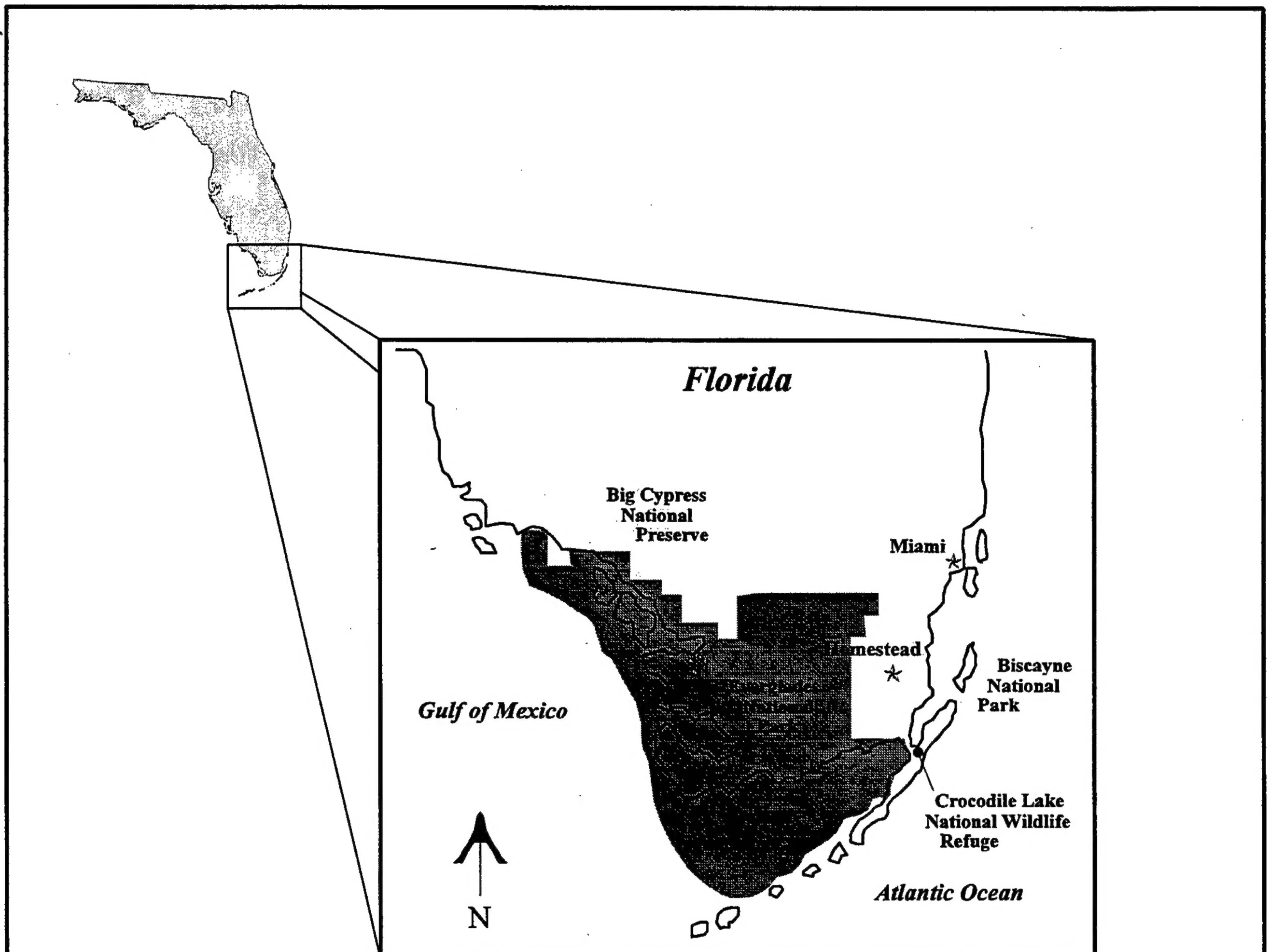
U.S. Department
of Transportation
Federal Aviation Administration

Ambient Sound Levels at Four Department of Interior Conservation Units

In Support of Homestead Air Base Reuse Supplemental Environmental Impact Statement

FAA-AEE-99-02
DOT-VNTSC-FAA-99-3

Final Report
June 1999



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John A. Volpe National Transportation Systems Center
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6. AUTHOR(S)
Gregg G. Fleming[1], Christopher J. Roof[1], David R. Read[1], Joseph Burstein[2], David Senzig[1], Amanda S. Rapoza[1], Paul Gerbi[2], Cynthia S.Y. Lee[1], Lynn Osovski[2], Kenneth D. Polcak[3], Jake A. Plante[4], John M. Gulding[4], Lynne S. Pickard[4], Ralph Thomson[4]

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13. ABSTRACT (Maximum 200 words)

The Federal Aviation Administration (FAA), in cooperation with the United States Air Force (USAF), is developing a Supplemental Environmental Impact Statement (SEIS) in support of the planned commercialization of Homestead Air Base in Southern Florida. As part of this SEIS it is important to analyze potential noise impacts in the areas surrounding the airport. An integral part of this undertaking is the comprehensive definition of the associated sound level environment. The FAA and USAF, with the assistance of the Acoustics Facility at the United States Department of Transportation's John A. Volpe National Transportation Systems Center, conducted ambient sound level measurements during the period August 10 through 20, 1998. In total, over 160 hours of acoustical and meteorological data were measured at 29 sites throughout Biscayne National Park, Everglades National Park, Crocodile Lake National Wildlife Refuge, and the southern portion of Big Cypress National Preserve. This document summarizes this comprehensive noise measurement study. Also included is a description of the enhancements made to the FAA's Integrated Noise Model (INM) in support of the Homestead SEIS.

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METRIC/ENGLISH CONVERSION FACTORS

ENGLISH TO METRIC

LENGTH (APPROXIMATE)

1 inch (in) = 2.5 centimeters (cm)
1 foot (ft) = 30 centimeters (cm)
1 yard (yd) = 0.9 meter (m)
1 mile (mi) = 1.6 kilometers (km)

AREA (APPROXIMATE)

1 square inch (sq in, in^2) = 6.5 square centimeters (cm^2)
1 square foot (sq ft, ft^2) = 0.09 square meter (m^2)
1 square yard (sq yd, yd^2) = 0.8 square meter (m^2)
1 square mile (sq mi, mi^2) = 2.6 square kilometers (km^2)
1 acre = 0.4 hectare (ha) = 4,000 square meters (m^2)

MASS - WEIGHT (APPROXIMATE)

1 ounce (oz) = 28 grams (gm)
1 pound (lb) = .45 kilogram (kg)
1 short ton = 2,000 pounds (lb) = 0.9 tonne (t)

VOLUME (APPROXIMATE)

1 teaspoon (tsp) = 5 milliliters (ml)
1 tablespoon (tbsp) = 15 milliliters (ml)
1 fluid ounce (fl oz) = 30 milliliters (ml)
1 cup (c) = 0.24 liter (l)
1 pint (pt) = 0.47 liter (l)
1 quart (qt) = 0.96 liter (l)
1 gallon (gal) = 3.8 liters (l)
1 cubic foot (cu ft, ft^3) = 0.03 cubic meter (m^3)
1 cubic yard (cu yd, yd^3) = 0.76 cubic meter (m^3)

TEMPERATURE (EXACT)

[(x - 32)(5/9)]°F = y°C

METRIC TO ENGLISH

LENGTH (APPROXIMATE)

1 millimeter (mm) = 0.04 inch (in)
1 centimeter (cm) = 0.4 inch (in)
1 meter (m) = 3.3 feet (ft)
1 meter (m) = 1.1 yards (yd)
1 kilometer (km) = 0.6 mile (mi)

AREA (APPROXIMATE)

1 square centimeter (cm^2) = 0.16 square inch (sq in, in^2)
1 square meter (m^2) = 1.2 square yards (sq yd, yd^2)
1 square kilometer (km^2) = 0.4 square mile (sq mi, mi^2)
10,000 square meters (m^2) = 1 hectare (ha) = 2.5 acres

MASS - WEIGHT (APPROXIMATE)

1 gram (gm) = 0.036 ounce (oz)
1 kilogram (kg) = 2.2 pounds (lb)
1 tonne (t) = 1,000 kilograms (kg) = 1.1 short tons

VOLUME (APPROXIMATE)

1 milliliter (ml) = 0.03 fluid ounce (fl oz)
1 liter (l) = 2.1 pints (pt)
1 liter (l) = 1.06 quarts (qt)
1 liter (l) = 0.26 gallon (gal)
1 cubic meter (m^3) = 36 cubic feet (cu ft, ft^3)
1 cubic meter (m^3) = 1.3 cubic yards (cu yd, yd^3)

TEMPERATURE (EXACT)

[(9/5)(y + 32)]°C = x°F

QUICK INCH-CENTIMETER LENGTH CONVERSION

INCHES	0			1		2			3		4			5
CENTIMETERS	0	1	2	3	4	5	6	7	8	9	10	11	12	13

QUICK FAHRENHEIT-CELSIUS TEMPERATURE CONVERSION

°F	-40°	-22°	-4°	14°	32°	50°	68°	86°	104°	122°	140°	158°	176°	194°	212°
°C	-40°	-30°	-20°	-10°	0°	10°	20°	30°	40°	50°	60°	70°	80°	90°	100°

For more exact and or other conversion factors, see NIST Miscellaneous Publication 286, Units of Weights and Measures. Price $2.50. SD Catalog No. C13 10286.

Updated 9/29/95

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The authors of this report wish to express their sincere gratitude to all who helped make this a successful study. The coordination and support provided by the National Park Service proved invaluable. In particular, we would like to thank Bill Schmidt (Washington, D.C.), Pat Lynch and his team at Biscayne National Park, Karyn Fero and her team at Everglades National Park, Steve Klett at Crocodile Lake National Wildlife Refuge, and Ron Clark at Big Cypress National Preserve. Additionally, the experience and insight provided by Gonzalo Sanchez of Sanchez Industrial Design, Inc., further enabled a successful study.

We would also like to thank Bill Evans and John Marks of Biscayne Helicopter who provided transportation to the Eastern Sparrow site; and thanks go to Bob Armstrong of Club Nautico for providing transportation to many of the Biscayne sites, as well as for his valuable knowledge of and insight into the Biscayne Bay area.

PREFACE

This document, entitled ***Ambient**** *Sound Levels at Four Department of Interior Conservation Units*, begins with an executive summary and glossary. Section 1 presents a general overview, including the objectives of the study. Section 2 describes the site selection process, including the pre-measurement scoping meeting. Section 3 discusses instrumentation. Section 4 presents the measurement procedures employed in the field. Section 5 discusses data reduction. Section 6 presents the results of the study, including the ambient sound level maps developed for each unit. Section 7 presents related references.

Appendix A lists the members of the research team along with their responsibilities. Appendix B presents a plan view of each measurement site. Appendix C contains information specific to the **noise** measurement system developed by the Volpe Center as part of this study. Appendix D summarizes the enhancements made to the FAA's Integrated Noise Model in support of this study.

* Terms contained in the Glossary are highlighted when they first appear in the main body of this document.

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EXECUTIVE SUMMARY

The United States Air Force (USAF) and Federal Aviation Administration (FAA) are the lead federal agencies preparing a Supplemental Environmental Impact Statement (SEIS) which will be used in making federal decisions about the proposed disposal of portions of former Homestead Air Force Base (AFB) in southern Florida. An important part of the SEIS is an analysis of noise impacts from proposed civil and military aircraft operations on four conservation units in southern Florida, namely Biscayne National Park (BNP), Everglades National Park (ENP), Crocodile Lake National Wildlife Refuge (CLK), and Big Cypress National Preserve (BCY).

This technical report describes the noise measurement program that was undertaken to provide data about the existing noise environment in these conservation units. An essential part of the process was the definition of ambient sound levels and the categorization of noise sources that constitute the existing ambient, including aircraft. Data from this report is being used in the SEIS to evaluate how a future commercial airport or a future commercial spaceport at Homestead could potentially affect the noise environment. This technical report also provides an overview of enhancements made to the FAA's Integrated Noise Model (INM) to improve its noise prediction capabilities relative to terrain characteristics associated with the conservation units (i.e., the predominance of water, which is an acoustically hard surface and reflects noise differently than land, which is considered to be an acoustically soft surface).

In order to produce data on the affected noise environment in the conservation units and to develop INM enhancements, the FAA requested the technical assistance of the Acoustics Facility at the U.S. Department of Transportation's John A. Volpe National Transportation Systems Center (Volpe Center). A Volpe Center research team, with FAA participation, conducted extensive ambient sound level measurements at the four national conservation units (i.e., BNP, ENP, CLK, and BCY). Figure 1 illustrates the general locations of these four conservation units relative to Homestead.

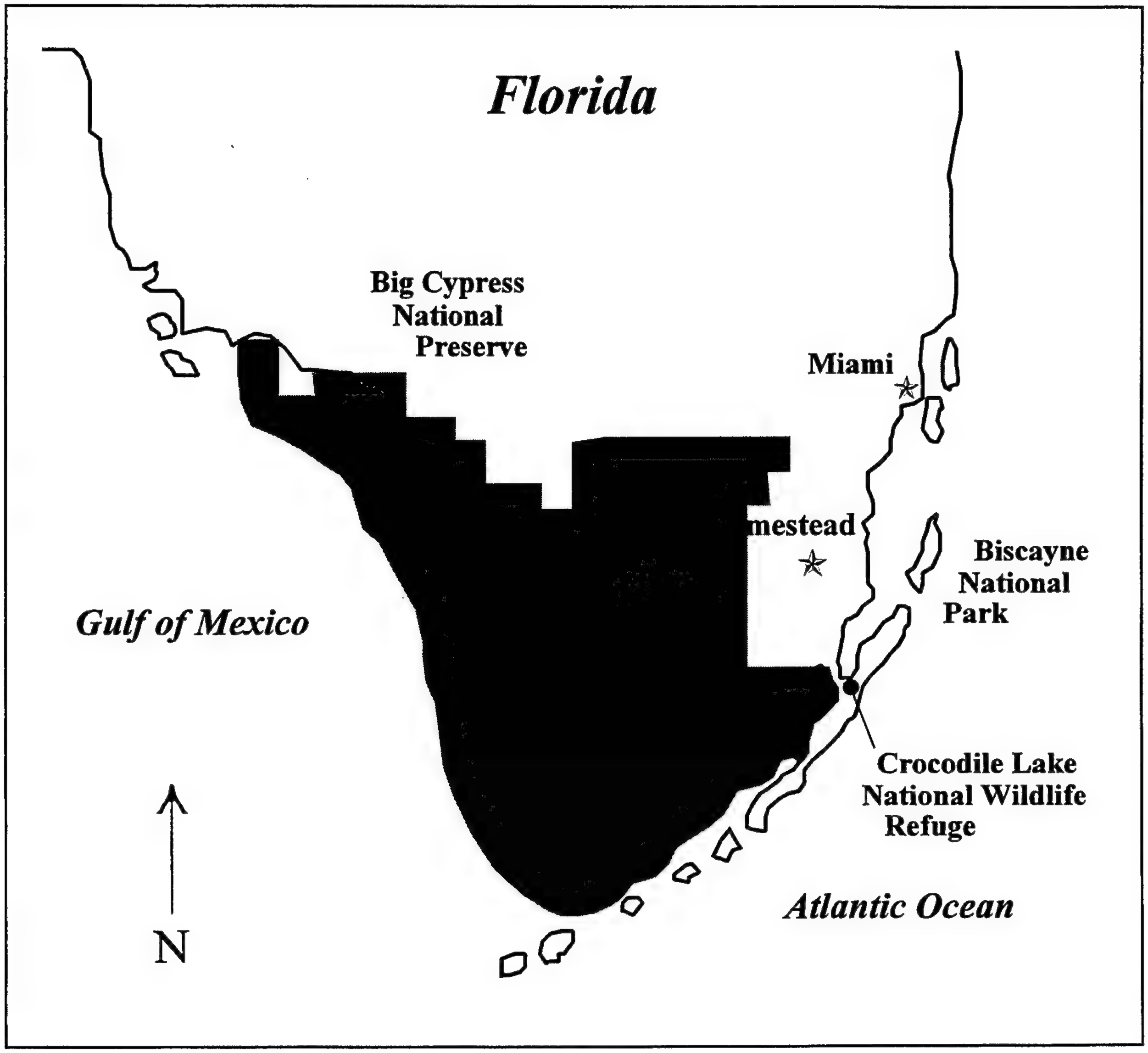


Figure 1. Relative Location of Four Conservation Units in Southern Florida

An initial scoping visit was made to the region during the period July 8 through 10, 1998. During this visit, the National Park Service (NPS) presented the research team with a list of 28 prioritized measurement sites. The primary criterion used by the NPS to identify sites was *resource protection*. Specifically, noise sensitive locations such as educational centers, wildlife habitats, and campgrounds dominated the NPS site listing. While the research team considered resource protection to be an important issue, there were several other criteria which the team considered equally, if not more, important to achieve the objective of characterizing the ambient sound level environment over a large amount of area. They included *representative land cover*, *geographic coverage* and *logistics/access*. Fortunately, many of the NPS-proposed sites that were selected from the standpoint of *resource protection* also provided *representative land cover* and adequate *geographic coverage*.

The field measurement procedures employed in support of this study were based almost entirely on the 1998 FAA/Volpe Center publication entitled *Draft Guidelines for the Measurement and Assessment of **Low-Level** Ambient Noise* (Guidelines Document), which describes in detail the methodology to be used in accurately characterizing a low-level sound environment. Although components of the Guidelines Document have been used in previous studies, this study represents the first rigorous implementation of the procedures.

Measurements were conducted by the research team during August 10 through 20, 1998, at 29 sites throughout the four units, eleven sites in BNP, thirteen in ENP, three in CLK and two in BCY. The measurement data include a total of 160 hours of acoustical and meteorological data at the 29 sites. For the purpose of examining repeatability (one indication of the quality of the data), measurements were conducted on two separate occasions for 12 sites, and on three separate occasions for 6 sights. For the remaining 11 sites, measurements were only performed once. In most cases, a typical measurement period was three hours in duration. Although measurements were conducted at two sites during the late evening/early morning time frame, measurement periods were generally selected

so as to encompass a substantial portion of the daylight hours, when it was thought that visitor activity would be at its peak. In addition, several sites were targeted for weekend measurements. These sites were primarily located in BNP, where it was expected that sound levels associated with increased weekend boat traffic would likely be higher.

In order to accurately assess the potential impact due to all noise sources, data were reduced and ambient sound levels were computed according to the following four sound level definitions (from the Guidelines Document):

Existing Ambient: The composite, all-inclusive sound associated with a given environment, excluding only the analysis system's electrical noise. Aircraft noise *is* included.

Traditional Ambient: The composite, all-inclusive sound associated with a given environment, excluding the analysis system's electrical noise and the sound source of interest, which in this case is aircraft. In effect, traditional ambient is existing ambient, excluding aircraft.

Natural plus Visitor Self-Noise (N+VSN): As defined by the NPS in the 1995 Report to Congress, the natural sound conditions found in a study area, including all sounds of nature (i.e., wind, streams, wildlife, etc.) *and* visitor-generated self-noise, excluding all mechanical sounds and the analysis system's electrical noise. Visitor self-noise includes voices, footsteps and other sounds that a visitor creates.

Natural Ambient: The natural sound conditions found in a study area, including all sounds of nature (i.e., wind, streams, wildlife, etc.), excluding all human and mechanical sounds as well as the analysis system's electrical noise (i.e., *only* the sounds of nature).

The selection of the ambient measurement definition among the four to focus on for the Homestead SEIS analysis was made based on: (1) requirements of the National Environmental Policy Act (NEPA) as implemented by the regulations of the President's Council on Environmental Quality (CEQ) and in FAA environmental guidance; and (2) technical determinations. In accordance with NEPA, as implemented by CEQ regulations, the affected environment is to be described. The affected noise environment in the conservation units includes all sounds-the sounds of nature, visitors, mechanical (e.g., equipment, cars, motorboats), and existing aircraft noise from Homestead and other airports in the general area.

The existing ambient appeared to be the appropriate definition of the existing affected noise environment. However, as explained in more detail in Section 6.2 of this report, it was determined that the aircraft noise component of the existing ambient could be more accurately and usefully described using computer modeling instead of short-term measurement data. Therefore, the traditional ambient measurement data were selected to be used in the SEIS, with aircraft noise as calculated by the Integrated Noise Model added to the traditional ambient in the SEIS noise analysis. The measured traditional ambient sound levels are presented for each site in figures 2 through 5.

Other technical factors worked against the selection of the natural ambient or the natural plus visitor self-noise ambient, in addition to the fact that neither includes all sounds contributing to the affected environment. The abundance of man-made activity (mostly mechanical sounds) at many sites, especially in Biscayne National Park, often minimized the duration of natural and natural plus visitor ambients, thus diminishing their reliability and usefulness. The detailed findings of the measurement program are presented in this document, including data on all four ambient measurements, although the primary focus is on the traditional ambient measurement and this is the ambient that is mapped.

In addition to the measurements done by the FAA/Volpe Center research team, the National Park Service requested Sanchez Industrial Design, Inc. (SID) to conduct similar ambient sound level measurements in September and October of 1997 and November of 1998. The NPS/SID measurements included 12 sites also measured by the FAA/Volpe Center research team, plus 8 additional sites. The data from both measurement efforts, FAA/Volpe and NPS/SID, were used to calculate the average traditional ambient sound levels used for ambient mapping and as reference points in the SEIS. Table 1, following this page, presents a summary of the measurement sites along with the average traditional ambient sound level at each site. Section 6.8 of this report describes the ambient mapping process.

The traditional ambient sound levels range from a low of 31.2 dB at Eastern Sparrow in Everglades National Park to a high of 64.0 dB at an NPS/SID measured site in Big Cypress National Preserve. However, the majority of the measured sound levels are between 45 and 55 dB. For the two sites where nighttime measurements were made (Black Point and Mangrove Key), traditional sound levels were within 3 dB of daytime measurements. With only two exceptions, the traditional and existing ambient sound levels were within 5 dB of each other (typically within 3 dB).

With respect to enhancements to the Integrated Noise Model (INM), in 1997 the FAA, in consultation with the Society of Automotive Engineers (SAE) A-21 Committee on Airport Noise, initiated the task of revising the overground propagation algorithms within the INM. The new approach is founded in acoustic theory and has undergone rigorous laboratory and field tests at relatively short source-to-receiver propagation distances. Unlike previous versions of the INM, this enhanced capability allows for proper consideration of mixed, acoustically hard and acoustically soft terrain. As such, it was considered most appropriate for evaluating noise impacts in support of the Homestead SEIS, primarily because of the vast wetland environment in southern Florida. The technical details

Table 1. Summary of Measurement Site Locations

Site Name	Site ID	Latitude	Longitude	Traditional Ambient (dB)
Biscayne National Park (BNP)				
Black Point	A	25 31 47 N 25 32 04 N	80 17 57 W 80 18 01 W	51.8
Boca Chita	C/SID	25 31 28 N	80 10 33 W	48.2
Elliott Key	I/SID	25 27 14 N	80 11 45 W	48.6
Featherbed Bank	P/SID	25 29 57 N 25 31 29 N 25 30 01 N	80 14 16 W 80 14 31 W 80 14 16 W	49.6
Fender Point	F	25 28 11 N 25 28 09 N 25 28 09 N	80 20 26 W 80 20 26 W 80 20 26 W	47.3
Mangrove Key	H	25 24 12 N 25 24 12 N 25 24 17 N	80 19 04 W 80 19 04 W 80 18 54 W	45.1
Pacific Reef	E/SID	25 22 03 N	80 08 54 W	51.6
Rubicon Key	D/SID	25 23 27 N 25 23 31 N	80 13 58 W 80 14 01 W	49.8
Soldier Key	L/SID	25 35 28 N	80 09 39 W	56.2
Stiltsville	J	25 37 18 N 25 37 17 N 25 37 45 N	80 08 54 W 80 08 57 W 80 12 06 W	54.9
Visitor Center	G/SID	25 27 52 N	80 20 05 W	56.2
Everglades National Park (ENP)				
Anhinga Trail	B/SID	25 23 01 N	80 36 22 W	54.2
Buchanan Key	Y	24 54 58 N	80 46 29 W	45.8
Chekika	O	25 36 45 N	80 35 04 W	41.0
Eastern Panhandle	M	25 17 16 N	80 26 30 W	54.9
Eastern Sparrow	V	25 29 52 N	80 39 45 W	31.2
Eco Pond	Q/SID	25 08 19 N	80 56 16 W	47.2
Hidden Lake	R	25 22 55 N	80 37 06 W	36.0
Little Madeira Bay	U	25 11 45 N 25 10 53 N	80 37 42 W 80 38 21 W	46.7
North Nest Key	X	25 09 06 N	80 30 41 W	39.9
Pavilion Key	AA	25 42 31 N	81 21 03 W	45.4
Pinelands	K/SID	25 25 22 N	80 40 47 W	46.5
Shark Valley	N	25 39 23 N	80 45 59 W	45.7

Site Name	Site ID	Latitude	Longitude	Traditional Ambient (dB)
Whitewater Bay	T	25 14 48 N	80 57 51 W	42.0
Broad River Campground	SID1	25 28 51 N	81 08 18 W	46.2
Pay-hay-okee	SID2	25 26 35 N	80 47 01 W	39.7
Nine-Mile Pond	SID3	25 15 19 N	80 47 52 W	44.6
Carl Ross Key	SID4	25 02 40 N	81 01 11 W	43.2
Canepatch Campground	SID5	25 25 19 N	80 56 38 W	39.0
Crocodile Lake National Wildlife Refuge (CLK)46.2				
Barnes Sound	AD/SID	25 14 29 N	80 20 03 W	39.2
Hardwood Hammock	W	25 15 56 N	80 18 39 W	41.3
Mangrove Inlet	AC	25 13 36 N	80 20 01 W	40.8
Big Cypress National Preserve (BCY)				
Golightly Campground	S	25 45 17 N	80 55 35 W	49.3
National Scenic Trail	AE	25 51 47 N	81 02 06 W	43.5
Halfway Creek	SID6	25 52 28 N	81 21 28 W	64.0
Bear Island	SID7	26 12 56 N	81 18 01 W	33.7
National Scenic Trail	SID8	26 13 04 N	81 04 25 W	34.1

associated with the INM-related enhancements are discussed extensively in Appendix D of this document.

Finally, the knowledge gained from this study will also contribute to the continued improvement of the Guidelines Document. The objective of a refined set of guidelines, having broad acceptance and use, is to facilitate the collection of consistent, repeatable ambient sound level data in virtually all low-level noise environments, including national parks.

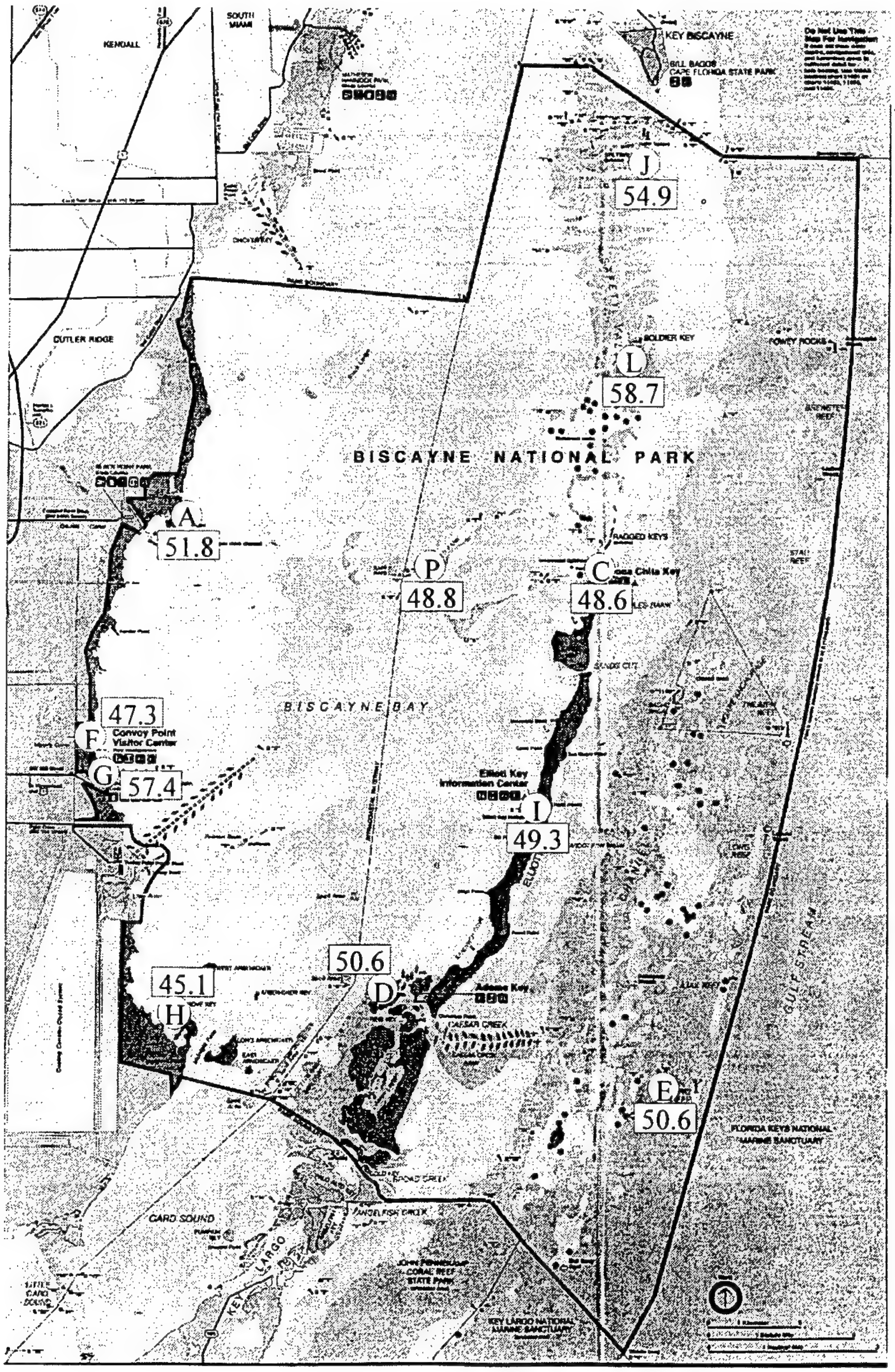


Figure 2. Traditional Ambient Sound Levels at Biscayne National Park (BNP)

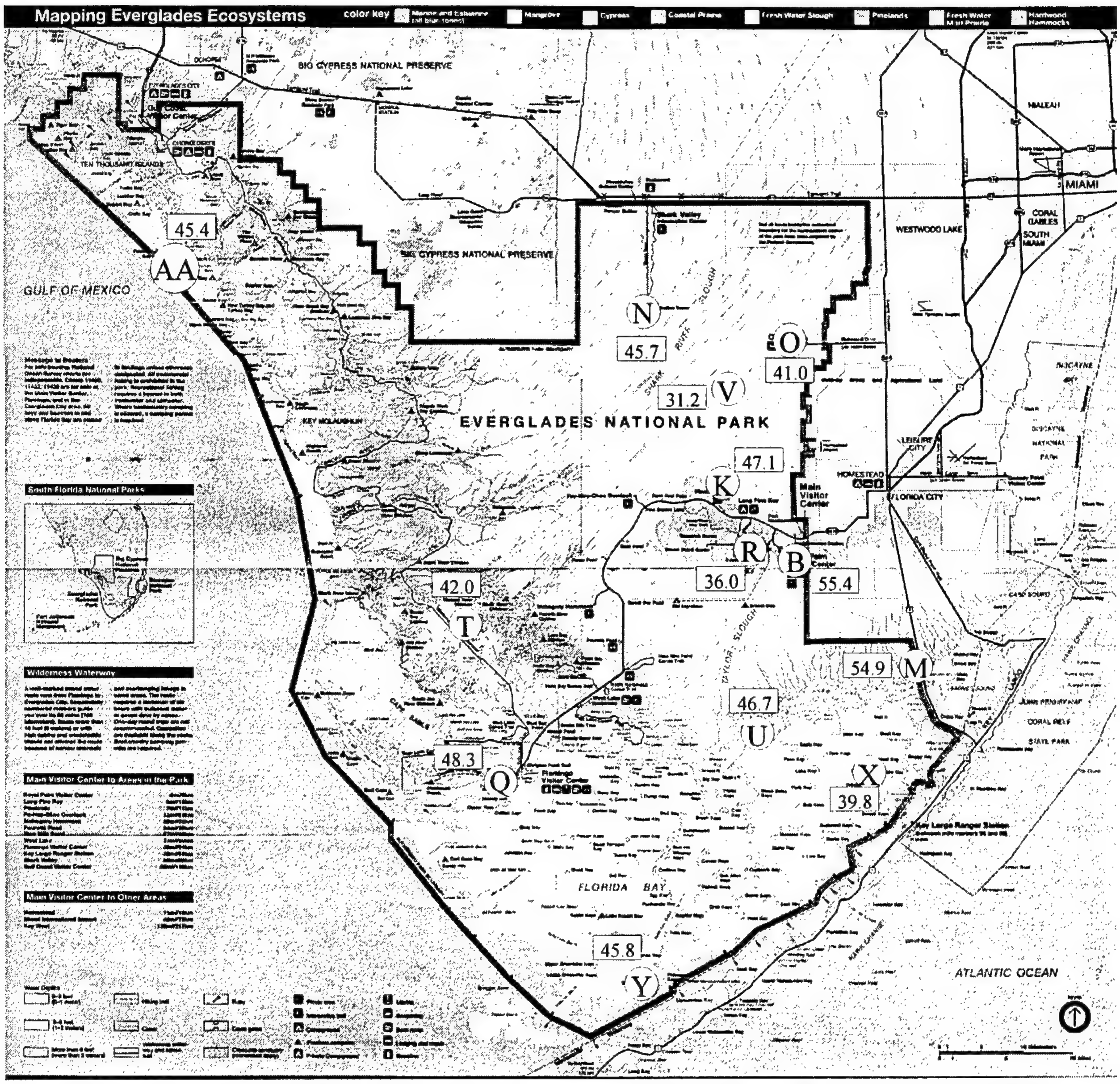


Figure 3. Traditional Ambient Sound Levels at Everglades National Park (ENP)

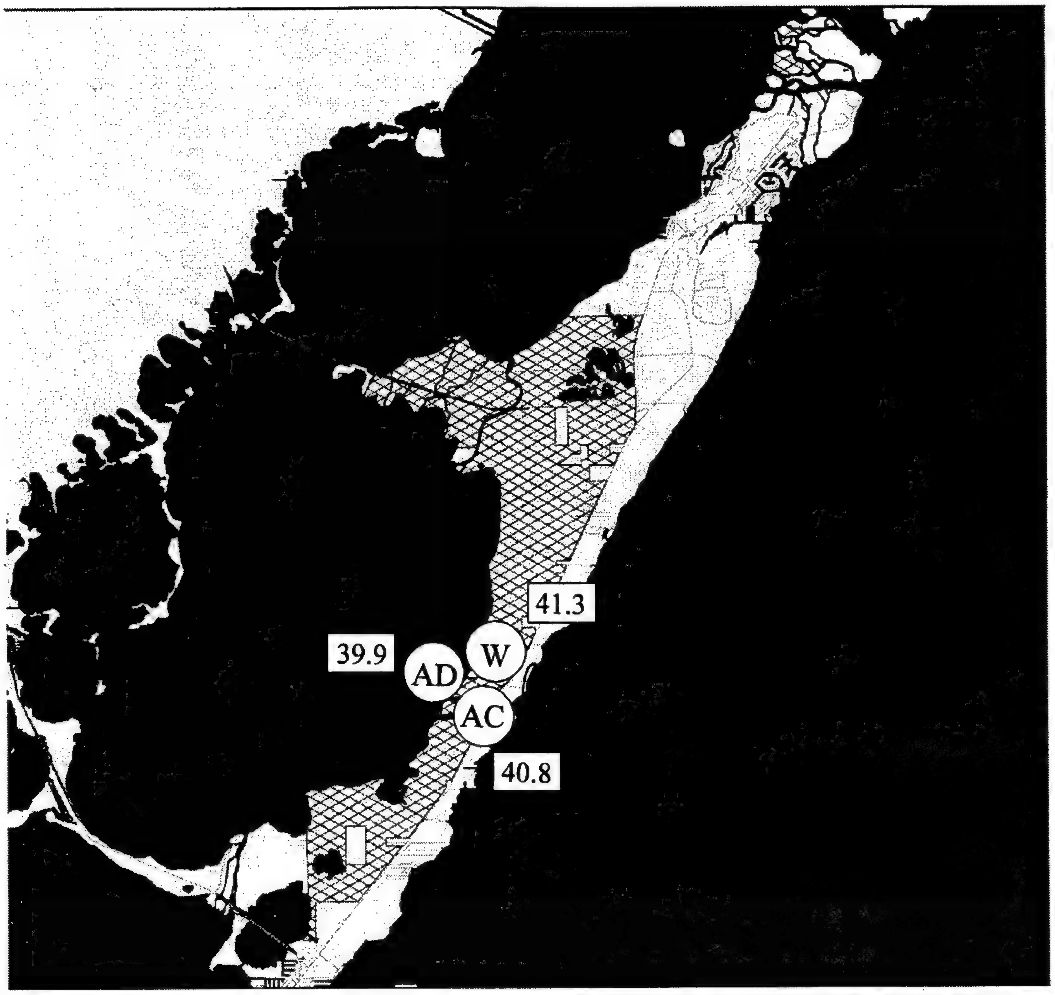


Figure 4. Traditional Ambient Sound Levels at Crocodile Lake National Wildlife Refuse (CLK)

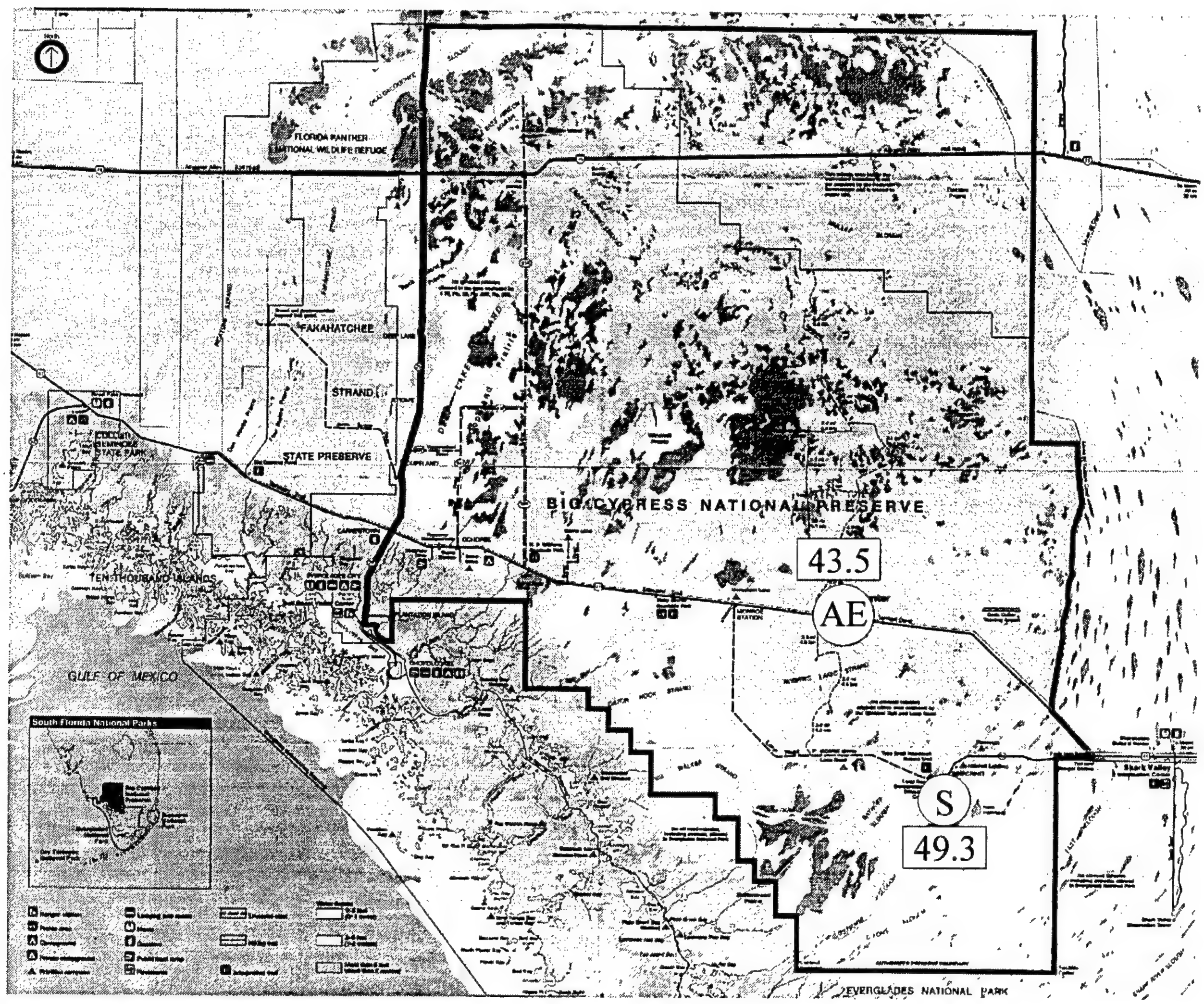


Figure 5. Traditional Ambient Sound Levels at Big Cypress National Preserve (BCY)

GLOSSARY

This section presents pertinent terminology used throughout the document. These terms are highlighted with boldface type when they first appear herein. Note: Definitions are generally consistent with those of the American National Standards Institute (ANSI)[1] and references two through four.

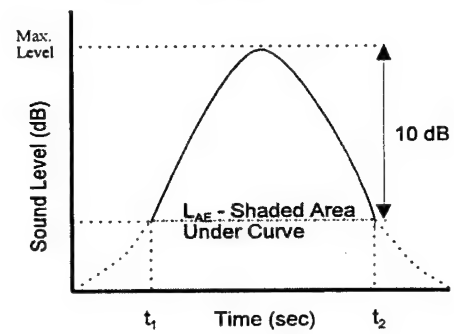
Term/Acronym	Definition/Full Name
A-Weighted	A weighting methodology used to account for changes in human hearing sensitivity as a function of frequency. The A-weighting network de-emphasizes the high (6.3 kHz and above) and low (below 1 kHz) frequencies, and emphasizes the frequencies between 1 kHz and 6.3 kHz, in an effort to simulate the relative response of human hearing.
Acoustic Energy	Commonly referred to as the mean-square sound-pressure ratio, sound energy, or just plain energy, acoustic energy is the squared sound pressure (often frequency weighted), divided by the squared reference sound pressure of 20 μPa, the threshold of human hearing. It is arithmetically equivalent to 10^{LEV+10}, where LEV is the sound level, expressed in decibels.
Ambient Noise	The composite, all-inclusive sound that is associated with a given environment (usually from many sound sources), excluding the analysis system's electrical noise and the sound source of interest, which in most cases presented herein is aircraft. See Section 5.2 for a more detailed discussion of ambient noise.
Audibility	The ability of a human observer to detect an acoustic signal in the presence of noise (e.g., aircraft detection in the presence of ambient noise).
Backcountry	Any location in a study area subject to minimal human activity, such as designated wilderness areas or restricted, hiking and camping areas (destinations generally located 1 hour or more from frontcountry locations).
Day-Night Average Sound Level	(DNL, denoted by the symbol L_{dn}): A 24-hour time-averaged sound exposure level (see definition below), adjusted for average-day sound source operations. In the case of aircraft noise, a single operation is equivalent to a single aircraft departure, approach, etc. The adjustment includes a 10 dB penalty for operations occurring between 2200 and 0700 hours, local time.

Decibel	(abbreviated dB): The decibel is a unit of measure of sound level. The number of decibels is calculated as ten times the base-10 logarithm of the squared sound pressure (often frequency weighted), divided by the squared reference sound pressure of 20 μPa, the threshold of human hearing.
Equivalent Sound Level	(TEQ, denoted by the symbol L_{AcqT}, also often referred to as LEQ): Ten times the base-10 logarithm of the time-mean-square, instantaneous A-weighted sound pressure, during a stated time interval, T (where $T=t_2-t_1$, in seconds), divided by the squared reference sound pressure of 20 μPa, the threshold of human hearing. L_{AcqT} is related to L_{AE} by the following equation: $L_{AcqT} = L_{AE} - 10 \times \log_{10}(t_2-t_1)$ (dB) Where L_{AE} = Sound exposure level (see definition below). The L_{Acq} for a specific time interval, T1 (expressed in seconds), can be normalized to a longer time interval, T2, via the following equation: $L_{AcqT2} = L_{AcqT1} - 10 \times \log_{10}(T2 \div T1)$ (dB)
Frontcountry	Any location in a study area subject to substantial human activity, such as scenic overlooks, visitor centers, recreation areas, or destinations reached by short hikes (1 hour or less).
INM	Integrated Noise Model, the noise modeling system designed and used by the FAA, as well as over 500 users worldwide, for noise assessment and prediction.
Low-Level Noise Environment	An outdoor sound environment typical of a remote suburban setting, or a rural or public lands setting. Characteristic average day-night sound levels (DNL, represented by the symbol L_{dn}) would generally be less than 45 dB, and the everyday sounds of nature, e.g., wind blowing in trees and birds chirping would be a prominent contributor to the DNL.

Maximum Sound Level	(MXFA or MXSA, denoted by the symbol L_{AFmx} or L_{ASmx}, respectively): The maximum, A-weighted sound level associated with a given event (see figure with definition of sound exposure level). Fast exponential response (L_{AFmx}) and Slow exponential response (L_{ASmx}) characteristics effectively damp a signal as if it were to pass through a low-pass filter with a time constant (τ) of 125 and 1000 milliseconds, respectively.
Natural quiet	The natural sound conditions found in a study area. Natural quiet is a subset of ambient noise. Traditionally, it is characterized by the total absence of human or mechanical sounds, but includes all sounds of nature, such as wind, streams, and wildlife. In a park environment, the National Park Service (NPS) on Page 74 of its Report to Congress defines natural quiet as the absence of mechanical noise, but containing the sounds of nature, such as wind, streams, and wildlife, as well as human-generated "self-noise" (e.g., talking, the tread of hiking boots on the trail, a creaking packframe, the rattle of pots or pans).
NODSS	National Park Service Overflight Decision Support System, the noise modeling system used by the NPS for noise assessment and prediction.
Noise	Broadly described as any unwanted sound. "Noise" and "sound" are used interchangeably in this document.

Sound Exposure Level	(SEL, denoted by the symbol L_{AE}): Over a stated time interval, T (where $T=t_2-t_1$, in seconds), ten times the base-10 logarithm of a given time integral of squared instantaneous A-weighted sound pressure, divided by the product of the squared reference sound pressure of 20 μPa, the threshold of human hearing, and the reference duration of 1 sec. The time interval, T, must be long enough to include a majority of the sound source's acoustic energy. As a minimum, this interval should encompass the 10 dB down points (see figure below).

Graphical Representation of L_{AE}



The L_{AE} can be developed from 1-second A-weighted sound levels (L_{Ak}) by the following equation:

$$L_{AE} = 10 \times \log_{10}\left[\sum_{k=t_1}^{t_2} 10^{L_{Ak} \div 10}\right] \qquad \text{(dB)}$$

In addition, L_{AE} is related to L_{AeqT} by the following equation:

$$L_{AE} = L_{AeqT} + 10 \times \log_{10}(t_2 - t_1) \qquad \text{(dB)}$$

Where L_{AeqT} = Equivalent sound level in dB (see definition above).

Sound pressure level	(abbreviated SPL): Ten times the base-10 logarithm of the time-mean-square sound pressure, in a stated frequency band (often frequency-weighted), divided by the squared reference sound pressure of 20 μPa, the threshold of human hearing. $SPL = 10 \times \log_{10}[p^2 \div p_{ref}^2]$ Where p^2 = time-mean-square sound pressure; and p_{ref}^2 = squared reference sound pressure of 20 μPa.
Spectrum	A signal's resolution expressed in component frequencies or fractional octave bands.

1. Introduction

The United States Air Force (USAF) and Federal Aviation Administration (FAA) are the lead federal agencies preparing a Supplemental Environmental Impact Statement (SEIS) which will be used in making federal decisions about the proposed disposal of portions of former Homestead Air Force Base in southern Florida. An important part of the SEIS is an analysis of noise impacts from proposed civil and military aircraft operations on four conservation units in south Florida, namely Biscayne National Park (BNP), Everglades National Park (ENP), Crocodile Lake National Wildlife Refuge (CLK), and Big Cypress National Preserve (BCY).

In support of the SEIS noise analysis for the conservation units, the FAA requested the assistance of the Acoustics Facility at the United States Department of Transportation's John A. Volpe National Transportation Systems Center (Volpe Center) to conduct measurements of ambient sound levels in the conservation units, to undertake ambient mapping of the properties based on measurements, and to develop enhancements to the FAA's Integrated Noise Model (INM) to improve its prediction of aircraft noise effects on water surfaces which are so prevalent in south Florida.

The Volpe Center conducted ambient sound level measurements during the period August 10 through 20, 1998. In total, over 160 hours of acoustical and meteorological data were measured by the research team at 29 sites throughout the four conservation units. This document summarizes this comprehensive noise measurement study. In addition to the Volpe Center's measurement effort, the U.S. National Park Service (NPS) requested the assistance of Sanchez Industrial Design, Inc. (SID) to conduct similar ambient sound level measurements in September and October of 1997 and November of 1998. The NPS/SID measurements included 12 sites also measured by the Volpe Center, plus 8 additional sites. The data from all of these measurement efforts were reviewed by the Volpe Center, in coordination with SID, to calculate the average traditional ambient sound levels used

for ambient mapping and as reference points in the SEIS. This document describes the ambient mapping procedure.

In addition, this document provides an overview of the enhancements made to the FAA's Integrated Noise Model (INM) to improve its noise prediction relative to the terrain characteristics associated with the conservation units (i.e., the predominance of water, which is an acoustically hard surface and reflects noise differently than land, which is considered to be an acoustically soft surface).

1.1 Objectives

A primary objective of this study is to describe the noise environment in the conservation units to provide input to the Homestead SEIS's analysis of potential changes to the noise environment. This objective has been accomplished by use of a two-step process of first measuring sound level data at a number of key locations, and then using the measured data along with other information to generalize the measured data over a larger area. A second primary objective of the study is to develop and document enhancements to the FAA's Integrated Noise Model (INM) to improve its noise prediction capabilities over mixed acoustically hard and soft surfaces.

An ancillary objective was to evaluate the recently completed draft Guidelines for the Measurement and Assessment of Low-Level Ambient Noise (Guidelines Document)[5], which describes in detail the methodology recommended for accurately characterizing a low-level sound environment. Components of the Guidelines Document have been used in previous studies[6,7], but this study represents the first rigorous implementation of the methodology in the Guidelines.

2. Site Selection

In early 1998, the research team (see Appendix A for an overview of the team) initiated the process of identifying the most suitable individual sites within BNP and ENP from the standpoint of characterizing the ambient sound level throughout these parks. Obviously, this process required joint support from the NPS. In fact, based on early discussions with the NPS, the study was expanded to include CLK and the southern portion of BCY, which were areas not originally considered by the research team.

When discussing the four conservation units in this document BNP is always presented first, followed by ENP, CLK and BCY. This protocol is used throughout, and is based on the proximity of each unit to Homestead Air Base.

All four conservation units are located in southern Florida (see Figure 6). BNP, established as a park in 1980, is approximately 180,000 acres, of which 95 percent is water, most of which is comprised of the Intra-coastal Waterway. The northern most point of BNP is less than 10 mi. south of downtown Miami, whereas the westernmost point is only about 3 mi. east of Homestead Air Base. Because it is almost entirely an aquatic park, BNP caters primarily to visitors interested in marine recreation. The coastal portion of the park is lined with extremely dense mangrove and, other than the immediate area surrounding the visitor center, offers little opportunity for the land-based park visitor. Some 6 to 8 mi off the coastal portion of the park, but still well within the park boundary lies the northernmost Florida Keys. Many of these 44 islands offer boating, beaching and camping areas for the park visitor. In addition, several miles to the east of these islands, expansive coral reefs provide park visitors with the opportunity to fish, snorkel and dive, among other activities (see Figure 7).

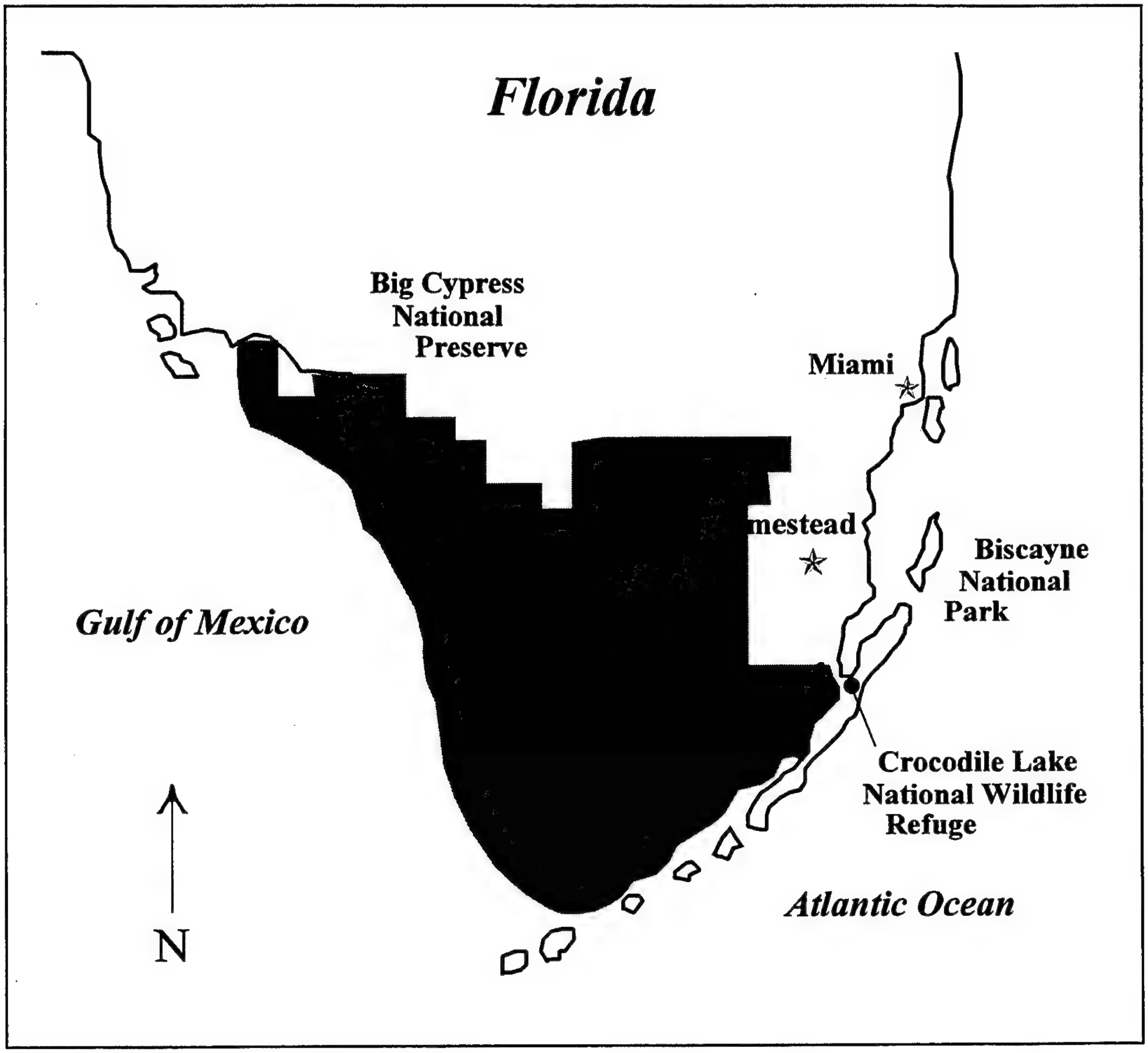


Figure 6. Relative Location of the Four Conservation Units in Southern Florida

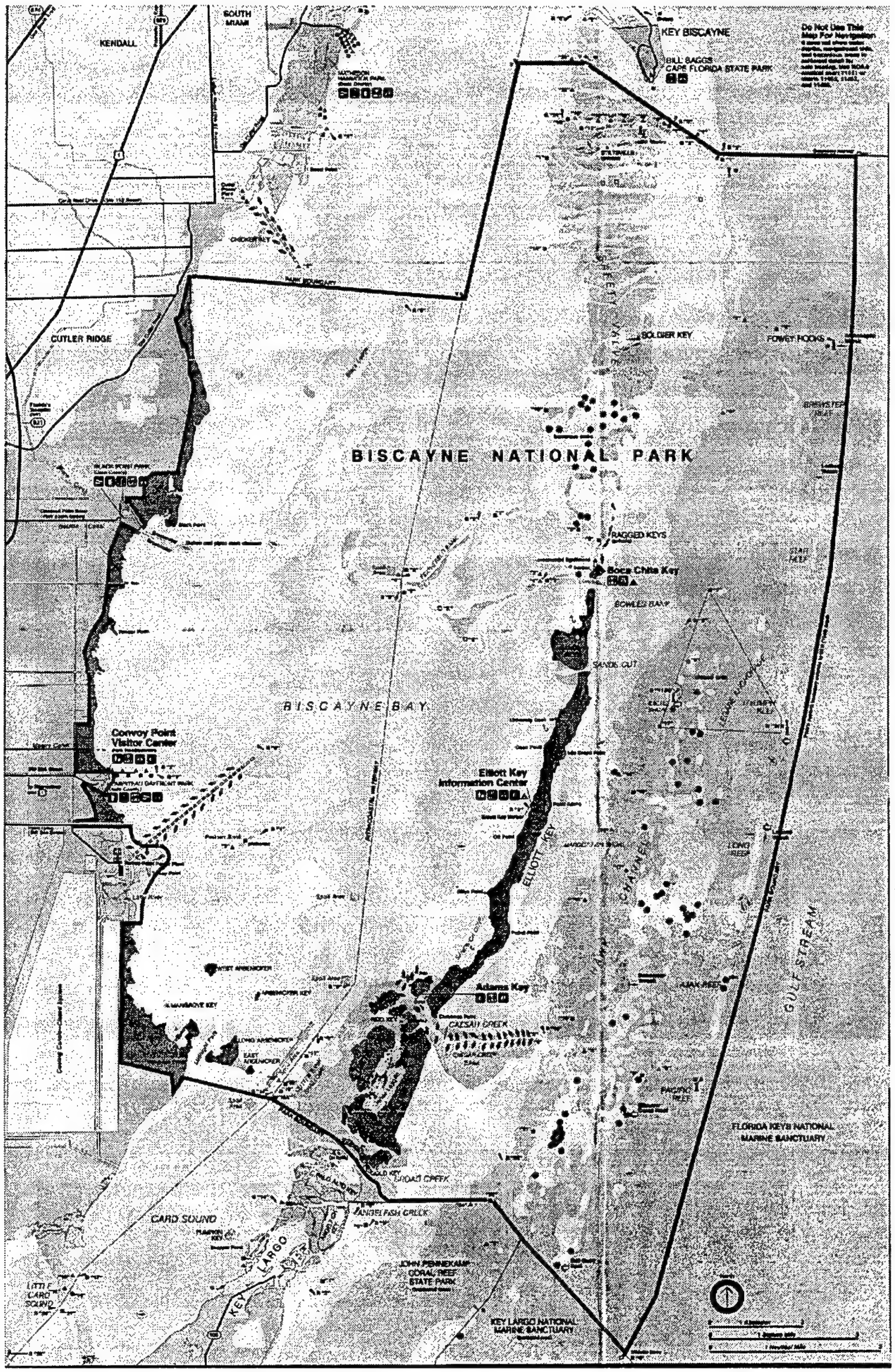


Figure 7. Biscayne National Park (BNP)

Located on the southern tip of the Florida peninsula, at approximately 1.5 million acres in size, ENP is by far the largest of the four conservation units included in the current study. The easternmost portion of the park is just about 11 mi. west of Homestead Air Base, while the northernmost park boundary extends up almost to the Miami parallel. ENP, which earned national park status in 1947, offers extensive camping areas throughout. The southernmost Florida Bay portion of the park offers boating and beaching; and the western portions of the park, just south of Everglades City, boast some of the best fishing in the country (Figure 8).

CLK, an approximately 6,700-acre wildlife refuge, was established in North Key Largo in 1980, to protect and preserve critical habitat for the American crocodile which has been placed on the federal endangered species list.[8] The mangrove wetlands which cover most of the preserve provide habitat and solitude for this shy reptile. Such vegetation also supports a wide variety of other wildlife including birds and many species of fish. CLK is approximately 15 mi. due south of Homestead Air Base (Figure 9).

BCY, the northernmost unit of the four studied, is located between Miami on the east coast of Florida and Naples on the west coast. It extends from the northern boundary of ENP to an area some 7 mi. north of Interstate 75. Originally established as Big Cypress Swamp in 1974, it now encompasses an area of some 729,000 acres. Because the northern most border of BCY extends some 50 miles north of Homestead Air Base, measurements by the Volpe Center were only conducted at two sites at BCY, both located in the southern portion of the unit that is closer to Homestead (Figure 10). Measurements at three additional sites at BCY, including one site also measured by Volpe, were conducted by SID.

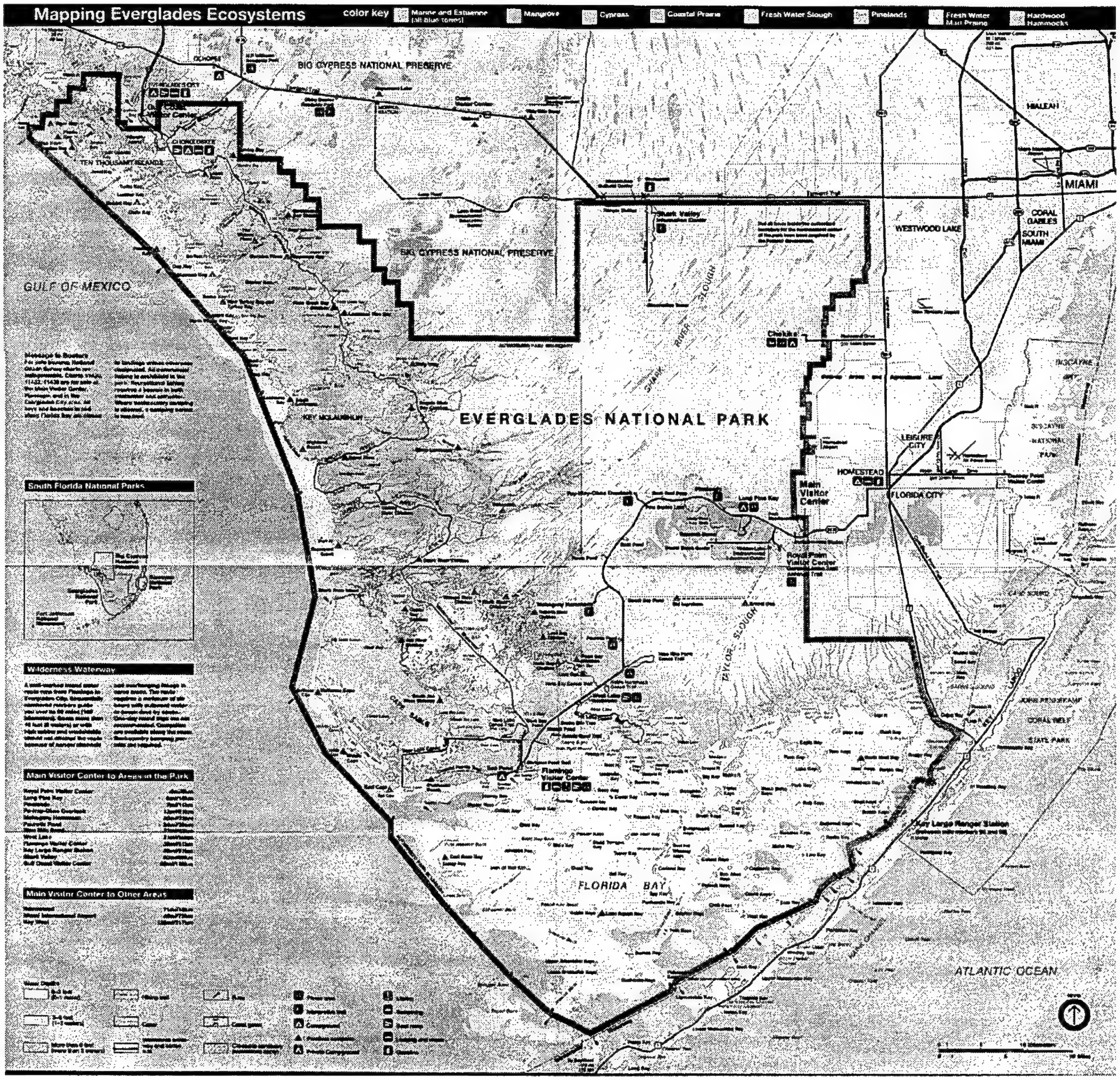


Figure 8. Everglades National Park (ENP)

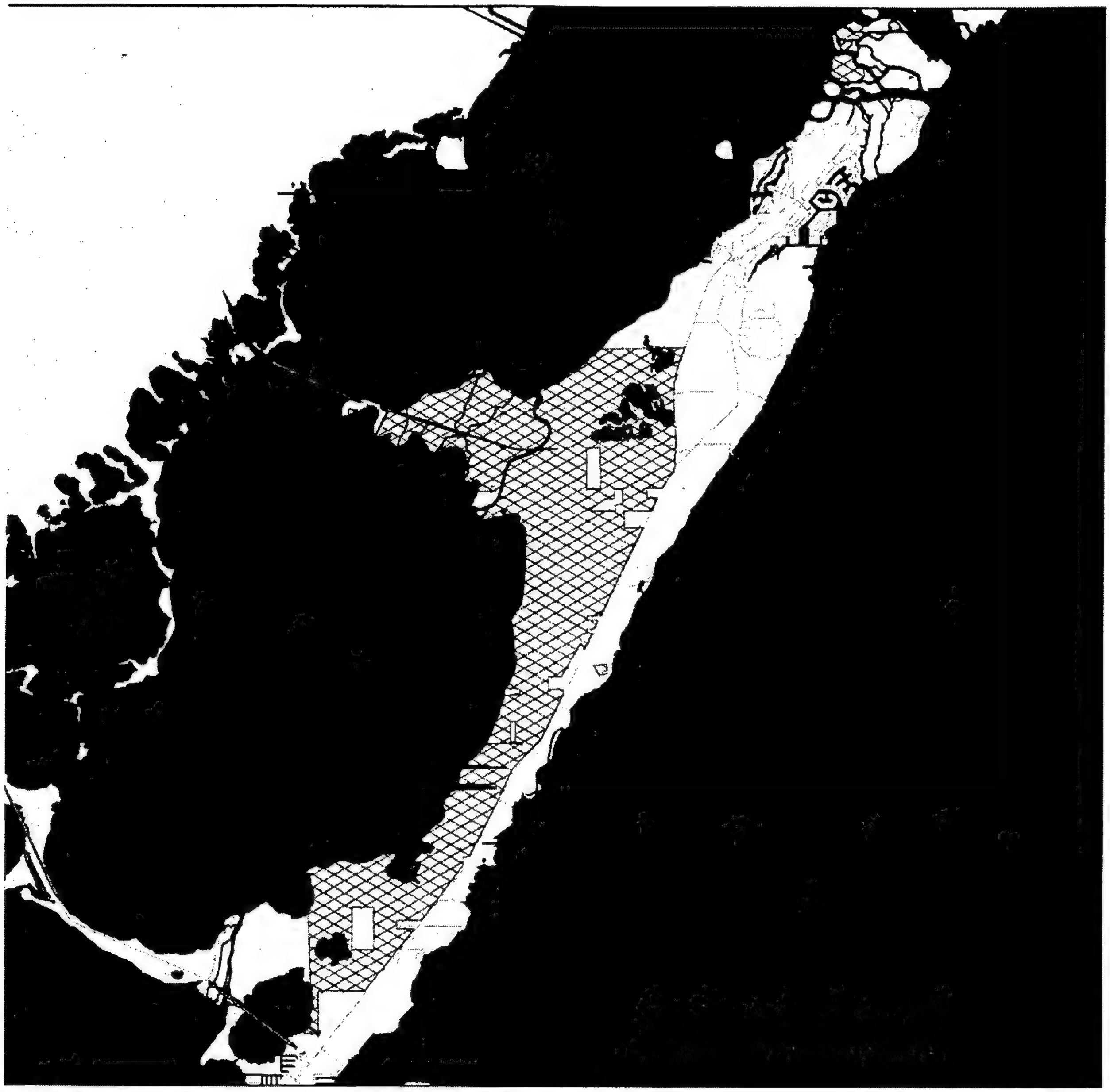


Figure 9. Crocodile Lake National Wildlife Refuge (CLK)

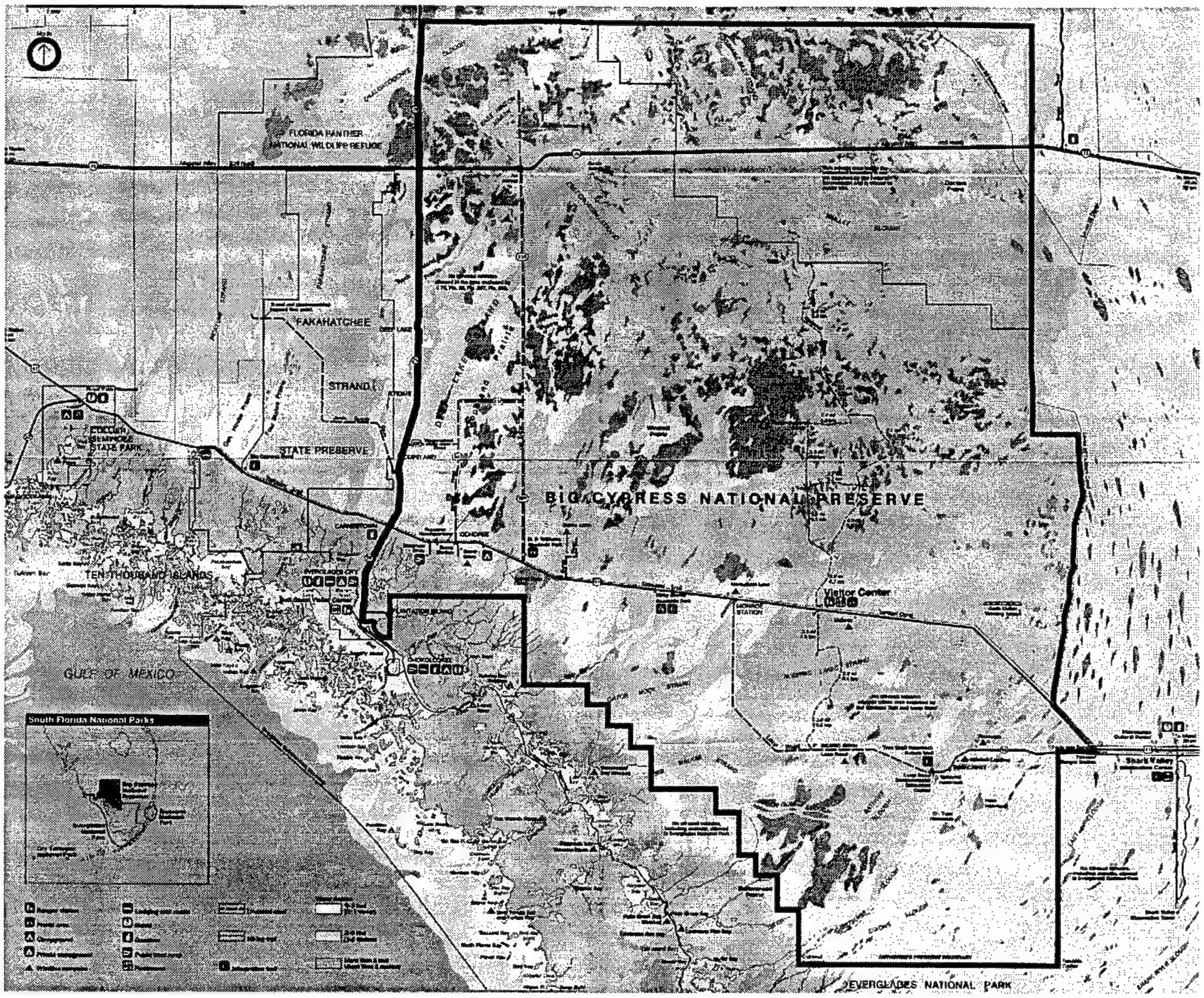


Figure 10. Big Cypress National Preserve (BCY)

The remainder of this section discusses in detail the site selection process, along with the 29 specific sites at which ambient sound level measurements were ultimately performed by the FAA/Volpe Center research team. Also included in the discussion is a summary of a scoping visit to BNP, ENP, CLK and BCY conducted by members of the research team in July 1998.

2.1 Selection Criteria

The primary goal of the ambient noise measurement site selection process was to efficiently identify the field-measurement sites which would provide adequate geographic coverage of the study area. As a part of the site selection process for this study, the research team identified four criteria for judging the acceptability of a proposed measurement site. These criteria are as follows:

> ***Representative Land Cover***: Similar studies in the national parks[6,7,9] have established an extremely strong correlation between land cover, wind speed and ambient sound level. In fact, the NPS's own **Noise Overflight Decision Support System (NODSS)** categorizes ambient sound levels in Grand Canyon National Park (GCNP) based solely on vegetative cover and wind speed.[10] The term vegetative cover has been generalized herein to land cover, since the vast majority of BNP and large portions of ENP are covered by water, as opposed to vegetation.
>
> The strong correlation between land cover and ambient sound level in a low-level ambient environment such as a non-urbanized national park is somewhat intuitive. Specifically, in such an environment, the vast majority of the contribution to the ambient sound level comes from wind blowing through the vegetation or across the surf, in the case of an aquatic environment. Further, the ambient sound level will change in direct proportion with the wind. This has been shown in the above previously referenced studies.[6,7,9,10]

Geographic Coverage: Representative land cover alone is not an adequate criterion to ensure the appropriateness of a measurement site. Geographic coverage is also very important. Even in a low-level ambient environment where the sounds of nature dominate, there can exist localized natural sounds which can largely influence measured levels. For example, measurement at one location along the Intra-coastal in BNP may not be adequate if at a second location on the waterway there is a populous bird sanctuary.

Resource Protection: Somewhat unrelated to representative land cover and geographic coverage, and in many ways as important, is resource protection. In fact, resource protection is *the* primary criteria of importance for the NPS. Specifically, it is the NPS position that noise-sensitive locations such as educational centers, wildlife habitats, campgrounds, etc., need to be represented in the study. The research team agreed to include such locations into the project scope. In many cases, the resource-specific sites were also used to represent specific land cover or to improve geographic coverage.

Logistics/Access: Overarching the above three criteria, and in many cases the definitive criterion in the final decision-making process, was site accessibility. As important as a given site was to satisfy any of the above criteria, if it was inaccessible, measurements could not be conducted. For example, conducting measurements in the mangrove forest along the shoreline of BNP was extremely difficult due to a general lack of roadways or hiking trails and the fact that the forest is so dense that trailblazing on foot is almost impossible. As an example, in one instance (the Fender Point site in BNP) access was gained via a dirt road which ran parallel to a drainage canal.

Prior to formal discussions with NPS personnel, the research team performed some preliminary investigation into the above four criteria, to determine the viability of individual measurement sites, or measurement areas.

With regard to *land cover* the research team contacted Science Applications International Corporation (SAIC). SAIC, the consultant ultimately responsible for the preparation of the Homestead SEIS, had obtained, from the Florida Game and Fresh Water Fish Commission (FGFWFC), an electronic file which contained land-cover data for the entire state of Florida.[11] The file represents the only land-cover data source known to the research team which includes all four conservation units in their entirety. It should be noted that researchers at ENP currently support a study with the University of Georgia to map out land cover for ENP; however this work has not yet been completed.[12] Basically, the portion of the FGFWFC file representing the four units contains 18 land-cover categories. These categories are summarized in Table 2 and graphically in Figure 11 for the pertinent southern area of Florida. This file was initially used as a means of identifying potential measurement areas, without regard to whether or not a particular area was practically accessible.

Table 2. Summary of Land-Cover Categories for Each Unit

FGFWFC Land-Cover Category (Type Code)	Percent of National Unit			
	BNP	ENP	CLK	BCY
Background (0)	62.65	5.72	-	0.02
Coastal Strand (1)	-	0.05	-	-
Dry Prairie (2)	<0.01	0.04	0.15	0.15
Pinelands (3)	-	0.64	-	4.09
Mixed Hardwood-Pine Forests (7)	-	<0.01	-	0.01
Hardwood Hammocks and Forests (8)	0.01	2.01	0.15	11.2
Tropical Hardwood Hammock (9)	0.88	0.01	14.35	-
Coastal Salt Marsh (10)	0.47	6.98	1.70	1.11
Freshwater Marsh and Wet Prairie (11)	0.01	25.41	-	36.9
Cypress Swamp (12)	-	0.31	-	39.61
Hardwood Swamp (13)	-	0.02	-	3.4
Scrub (Shrub) Swamp (15)	-	1.93	-	0.31
Mangrove Swamp (16)	2.23	23.1	66.17	1.05
Open Water (18)	33.43	32.42	11.63	0.13
Grassland (Agriculture) (19)	0.01	0.44	0.53	1.00
Shrub and Brush Land (20)	<0.01	0.02	-	0.02
Exotic Plant Communities (21)	0.02	0.02	-	-
Barren and Urban (22)	0.29	0.86	5.33	1.01

With respect to geographic coverage, preliminary studies of area maps indicated that coverage would to a large extent be governed by access. Specifically, it was determined that "gridding up" the four conservation units to obtain geographic coverage (as described in the Guidelines Document) simply was not practical due primarily to lack of access.

Little preliminary research was performed by the team itself in the area of resource protection. The research team agreed that the NPS was far more qualified in this area, and would provide the necessary expertise.

2.2 Scoping Visit

To help facilitate study planning, and to ensure that NPS requirements were adequately met, during the period July 8 through 10, 1998, several members of the research team conducted a site-scoping visit to the four conservation units. The three-day visit consisted of "round-table" discussions on the morning of the 8th and 9th and site visits during the remainder of the time period. Specifically, the late morning and afternoon period of the 8th was spent visiting sites in BNP and CLK. The afternoon of the 9th was spent visiting sites in the central and southern portions of ENP. The morning of the 10th was spent at sites in the northern portion of ENP, as well as the southern portion of BCY. Throughout the visit, discussions were conducted with park personnel, including Bill Schmidt (NPS Washington), Pat Lynch and Wendy O'Sullivan of BNP, Karyn Ferro, Barry Wood and Dave Sikkena of ENP, Steve Klett of CLK (U.S. Fish and Wildlife Service), Ron Clark of BCY (via telephone) and Gonzalo Sanchez of Sanchez Industrial Design (SID, an NPS consultant).

2.2.1 Topics of Discussion

Topics of discussion during the three-day visit included: (1) site priorities and access, including logistics; (2) the procedures for obtaining approval for performing measurements in the four

Coastal strand
Dry prairie
Pinelands
Xeric oak scrub
Mixed hardwood pine forests
Hardwood hammocks and forests
Tropical hardwood hammock
Coastal salt marshes
Freshwater marsh and wet prairie
Cypress swamp
Hardwood swamp
Shrub swamp
Mangrove swamp
Water
Grassland
Shrub and brushland
Exotic plant communities
Barren
Property Boundary

Figure 11. Graphical Display of Land-Cover Categories for Study Area

units, including the requirements for a brief research test plan; (3) aircraft and visitor activity at the four units; (4) expected weather conditions in the proposed August time frame; and (5) available land-cover and meteorological data.

In terms of the first discussion topic, the NPS presented the research team with a priority listing of 28 measurement sites, many of which were also of extremely high priority for the research team, based on preliminary investigation. The NPS objective in site identification was primarily resource protection, with a secondary goal of protecting visitor interests. The research team, as stated earlier, had a primary goal of representing all land-cover classes within the units, while providing for adequate geographic coverage. Throughout discussions, the research team assured the NPS that every effort would be made to perform measurements at the NPS priority sites.

NPS personnel indicated that site access would not be an issue. In fact, prior to commencement of the study, master keys were provided to the research team for all of the gates in BNP and ENP.

In terms of logistics, arrangements were made to have an NPS boat available each morning at BNP starting at 6:30 A.M., and at 8:30 P.M. for the limited amount of measurements planned for conduct at night.* Similar arrangements were discussed for water-based sites in the southern portion of ENP. Ultimately, arrangements were made directly with personnel at Key Largo Ranger Station and Everglades City Ranger Station.

The approval process for conducting research in the national parks includes a formal study design and application. The research team indicated that the study plan was currently in preparation and would be submitted within the next week.

* The NPS had identified two BNP sites, Black Point and Mangrove Key, at which they desired to have measurements conducted at night. Both sites were located adjacent to a bird sanctuary, and prior NPS research indicated birds to be especially noise-sensitive during the nighttime.

At the meeting, NPS personnel indicated that aircraft activity would be primarily dominated by Miami operations; however, at certain times of the day, operations out of Homestead Air Base could be substantial, especially for the sites in BNP. The NPS also indicated that there was a chance of a rare sightseeing or tour aircraft over the unit.

Park personnel indicated that peak visitation occurs, as expected in southern Florida, during the winter months. For the August timeframe in which measurements were planned, the visitor volume was expected to be relatively low. NPS personnel did however point out that in many areas of the units a substantial increase in visitor volume could be expected on the weekend, and that sites and specific measurement periods should be selected accordingly.

As far as weather, being in southern Florida during the summer would almost guarantee a late afternoon thunderstorm. NPS personnel identified the period between 2:00 P.M. and 4:00 P.M. as most susceptible to showers.

In terms of supplementary data (namely land-cover and meteorological) NPS personnel overviewed their available data and offered to provide the research team with any necessary support.

Additionally, at the two-day meeting, BCNP personnel provided the research team with ancillary material which would further facilitate planning of measurements at the four units. Such material included area maps, contacts, and a limited amount of meteorological data, with more to follow.

2.2.2 Site Visits

On July 8, NPS personnel led the research team on a tour of candidate sites in BNP and CLK, including, from north to south in BNP, Stiltsville, Black Point, Boca Chita, Featherbed Bank, Fender Point, Elliott Key, the Biscayne Visitor Center, Rubicon Key, Mangrove Key and Pacific Reef (see Figure 12; the letter designators in the figure are presented in Table 3 as the "Site ID"). In addition, several sites were visited in CLK, including Mangrove Inlet, Hardwood Hammock and Crocodile Pond (see Figure 13; the letter designators in the figure are presented in Table 3 as the "Site ID"). At most land-based sites, short excursions were taken down connecting trails in hopes of finding representative ambient measurement locations. The consensus of the research team was that all of the BNP and CLK sites offered reasonable access (although some only through the use of boats), and all provided representative microphone locations with the necessary wide range in land cover. With one exception, all were considered excellent candidate sites for the study. The one exception was Crocodile Pond because of its close proximity to Card Sound Road, a relatively busy thoroughfare. However, because the NPS considered this site to be an extremely high priority from the standpoint of resource protection (it was ranked third on their priority list), the research team agreed to include it in the study.

On July 9, NPS personnel led the research team on a tour of candidate sites in central and southern ENP, including, from north to south, Chekika, Pinelands, Anhinga Trail, Hidden Lake Educational Center and Eco Pond (see Figure 14; the letter designators in the figure are presented in Table 3 as the "Site ID"). Three of these sites, Pinelands, Anhinga Trail and Eco Pond, were not included on the NPS priority list, primarily because SID had performed measurements at these locations, or similar locations previously.[13] However, the research team felt that additional data was necessary at these sites to ensure adequate representation of particular land cover categories. Also, repeating measurements at sites similar to those included in the previous NPS study would allow for an assessment of measurement repeatability. Of the remaining two sites visited, the research team agreed that Chekika

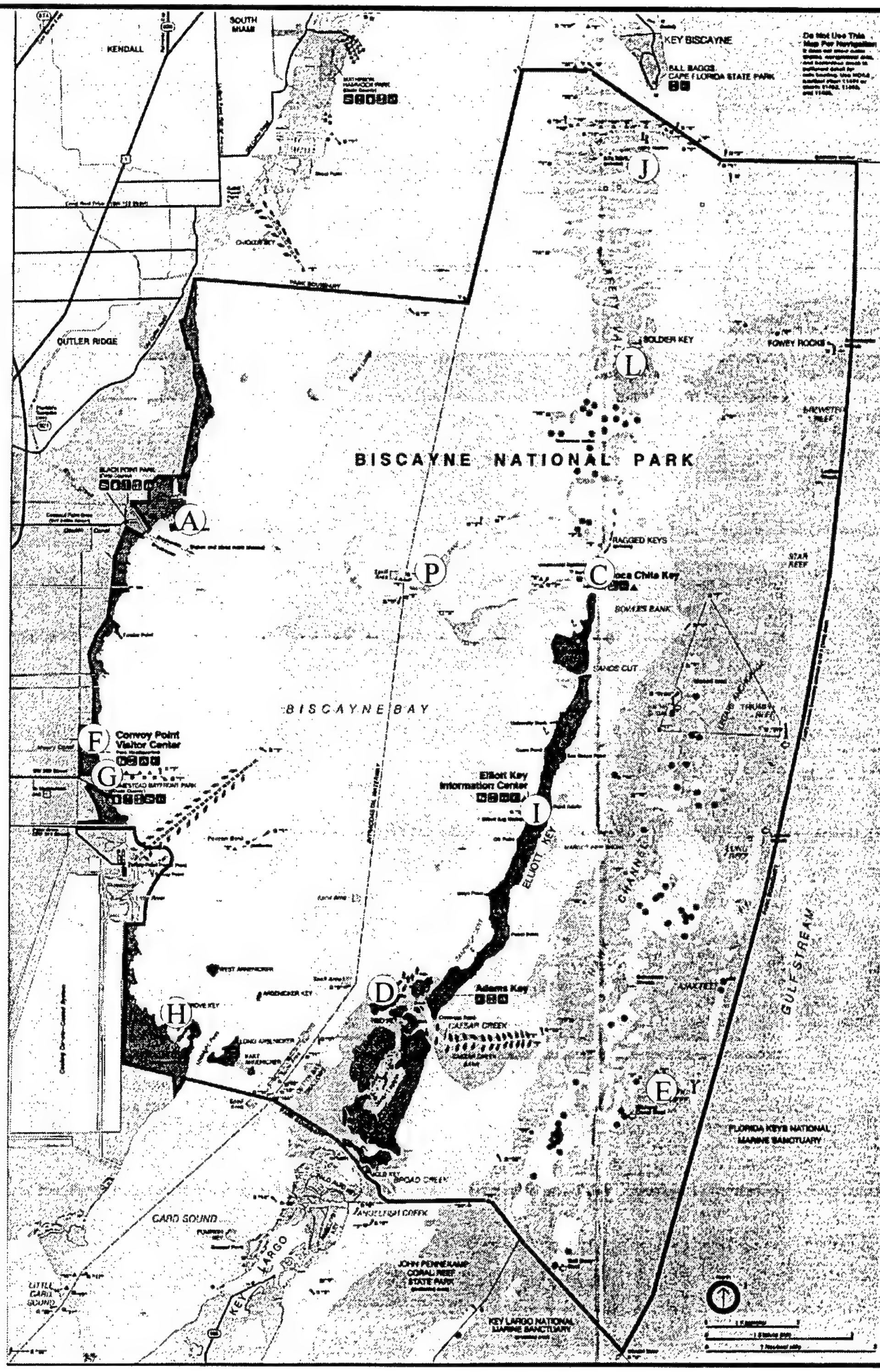


Figure 12. Location of Measurement Sites in Biscayne National Park (BNP)

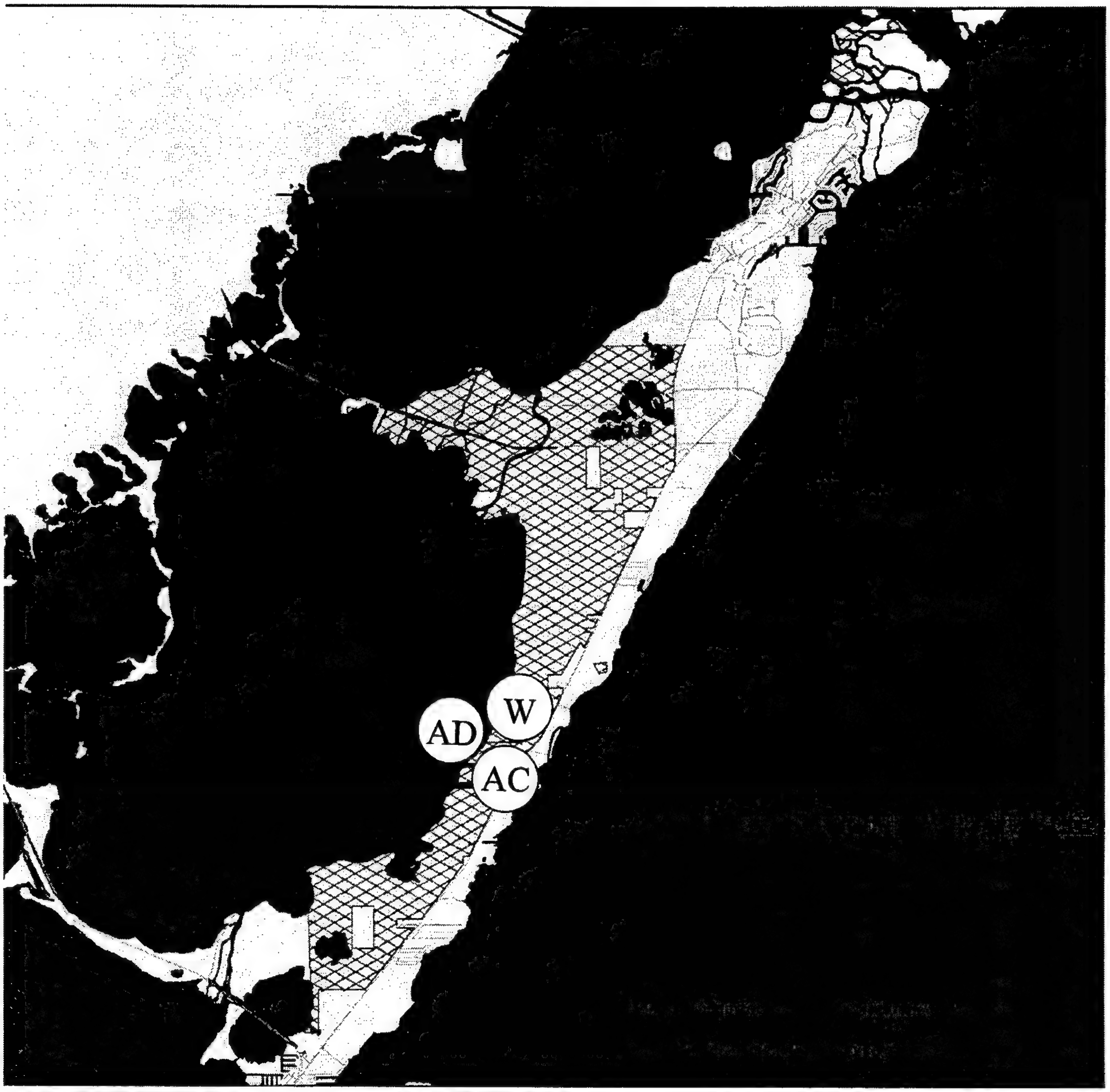


Figure 13. Location of Measurement Sites in Crocodile Lake National Wildlife Refuge (CLK)

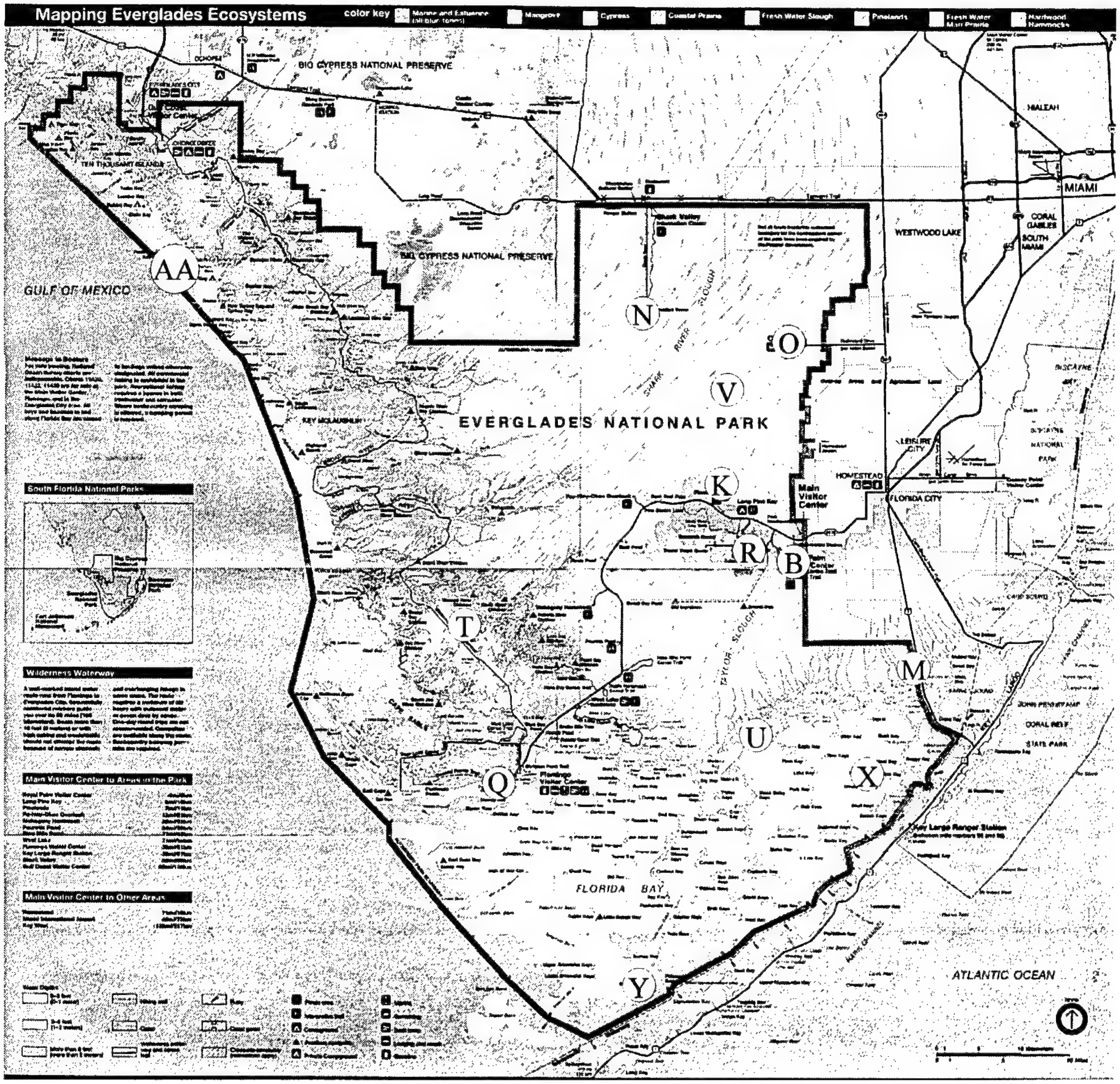


Figure 14. Location of Measurement Sites in Everglades National Park (ENP)

was essential to the goals of the study, but that Hidden Lake was probably not necessary because of its close proximity to Anhinga Trail (0.8 mi.) and Pinelands (4.8 mi.); but the team would try to include it in the study because of its importance to the NPS from the standpoint of resource protection.

On July 10, NPS personnel led the research team to the Loop Road Educational Center and the Golightly Campground in BCY (see Figure 15; the letter designators in the figure are presented in Table 3 as the "Site ID") and Shark Valley in ENP. It was later determined by NPS that access to the Loop Road Educational Center could not be arranged and that Golightly Campground, some 5,400 ft. (1.03 mi.) to the south, was a logical surrogate. The research team agreed that both the Golightly site and Shark Valley site were essential to the goals of the study.

In total, there were nine sites, seven in ENP (Buchanan Key, Eastern Panhandle, Eastern Sparrow, Little Madeira Bay, North Nest Key, Pavilion Key and Whitewater Bay) and two in BCY (Kissimee Billy Trail and National Scenic Trail), that were included on the original NPS priority list, but were not visited during the scoping visit. Five of these sites were either in Florida Bay or the Gulf of Mexico and were simply not practical to visit during the three-day scoping trip. However, the research team agreed that for the sake of geographic coverage every effort would be made to perform measurements at these sites (with the exception of Kissimee Billy Trail, which is discussed in more detail in the next paragraph).

Of the original 28 priority sites NPS identified, the research team agreed to make every effort to perform measurements at 25 of them (Note: Prior to measurements it was mutually agreed by the NPS and the research team that the ENP Canepatch site would be substituted by the Whitewater Bay site and the BCY Educational Center would be substituted by the Golightly Campground). The three NPS sites at which measurements were not performed included: (1) Kissimee Billy Trail, which is

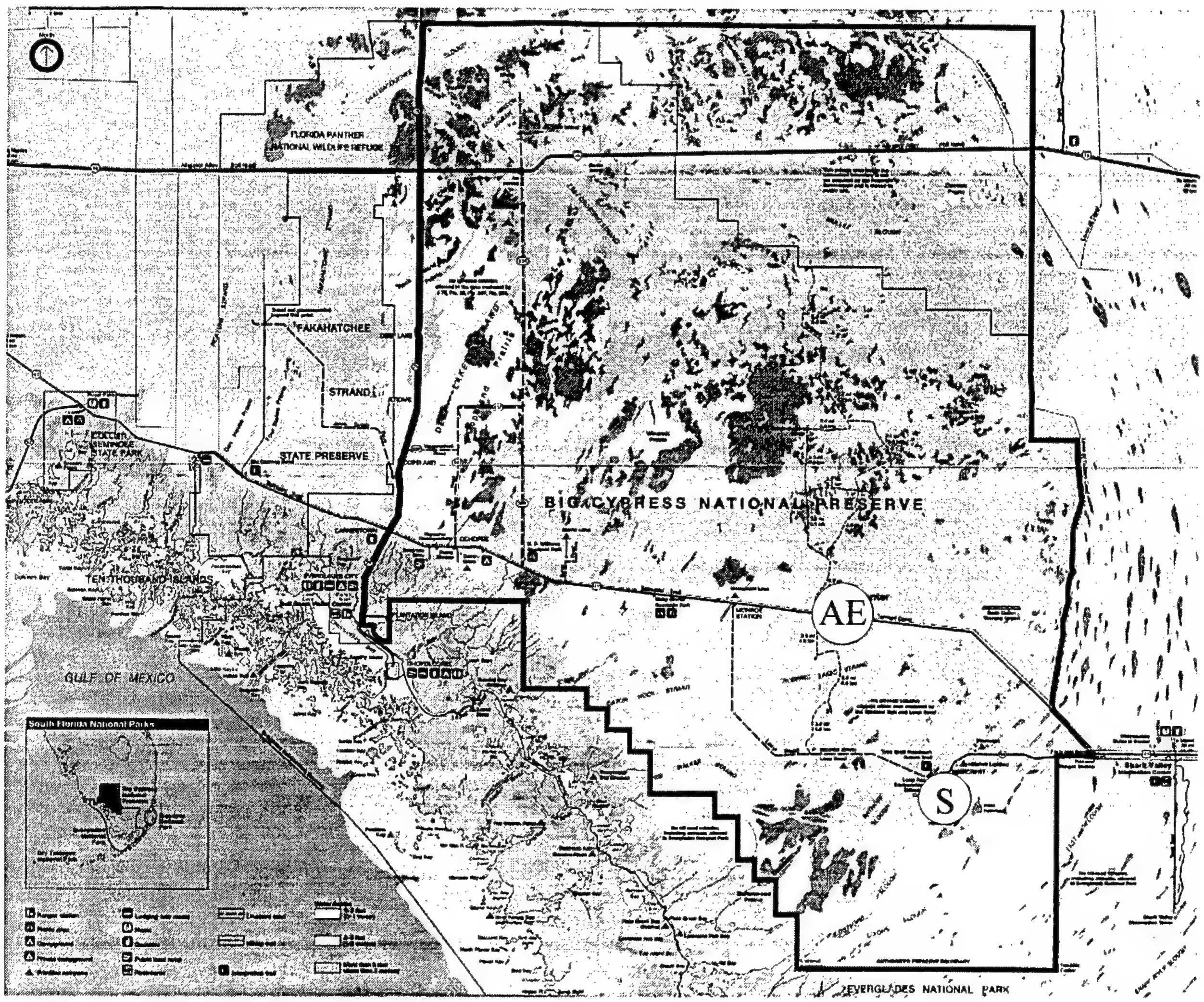


Figure 15. Location of Measurement Sites in Big Cypress National Preserve (BCY)

located about 30 mi. north of the Miami parallel and some 50 mi. northwest of Homestead, because of its long distance from Homestead and logistical concerns; (2) Fowey Light, which was mutually agreed by NPS and the research team to be adequately represented by the Pacific Reef site; and (3) North Panther Mound, which was mutually agreed to be adequately represented by Shark Valley, Eastern Sparrow and Pa-hay-okee (a site previously measured by SID for the NPS).

Ultimately, measurements were completed at all 25 original NPS priority sites (Note: During measurements it was mutually agreed by the NPS and the research team that the Crocodile Pond site would be substituted by Barnes Sound because of access issues). In addition to the 25 NPS priority sites, the research team identified four additional sites as necessary for ensuring proper coverage of the four units: (1) Soldier Key; (2) Anhinga Trail; (3) Eco Pond; and (4) Pinelands.

2.3 Measurement Sites

Figures 12 through 15 and Table 3 summarize the 29 sites at which ambient sound level measurements were performed. In the table, the sites are arranged in alphabetical order according to conservation unit: (1) 11 sites in BNP; (2) 13 sites in ENP; (3) 3 sites in CLK; and (4) 2 sites in BCY. The column headings in the table are defined as follows:

Site Name: The name assigned to the measurement site.

Date(s): The date or dates measurements were made at a particular site. For the purpose of examining repeatability, measurements were conducted on two separate occasions for 13 sites, and three separate occasions for 6 sites. For the remaining 10 sites, measurements were only performed once.

Site ID: An internal Volpe Center designator, included in the table for consistency with the field data log sheets. This designator is also used in Figures 12 through 15 for site identification.

Latitude/Longitude: The latitude and longitude measured at the site using a Magelian Pioneer GPS receiver (WGS-84 reference). With four exceptions, the coordinates for a particular site from one measurement day to the next (and referenced to the NPS-provided coordinates) were within the accuracy of GPS technology (roughly 300 ft. or 91.4 m). The exceptions were Black Point on 8/12, Featherbed on 8/14, Stiltsville on 8/17, and Little Madeira Bay on 8/20. The reason the exact coordinates were not observed on these four occasions was that the boat pilot on each day felt that it was a safety risk to move any closer to the precise coordinates due to tidal concerns.

Boat: This column is checked if the measurements were made from a boat, as opposed to measurements made from a land-based site.

NPS: This column is checked if measurements were previously conducted by the NPS at the identical or similar site.

Notes: Any special notes pertaining to the site.

Appendix B presents a plan view showing the instrumentation placement at each measurement site included in the study.

2.4 Research Team

Appendix A lists the members of the research team along with their responsibilities.

Table 3. Summary of FAA/Volpe Measurement Site Locations

Site Name	Date(s)	Site ID	Latitude	Longitude	Boat	NPS	Notes
Biscayne National Park (BNP)							
Black Point	8/10/98 8/12/98	A	25 31 47 N 25 32 04 N	80 17 57 W 80 18 01 W	✔		Variance in measurement locations due to tidal / maneuvering concerns. Measurements made on 8/12/98 were 1754 ft (approximately 0.3 mi) from those made on 8/10/98.
Boca Chita	8/10/98 8/13/98 8/15/98	C	25 31 28 N	80 10 33 W		✔	
Elliott Key	8/12/98 8/15/98 8/17/98	I	25 27 14 N	80 11 45 W		✔	
Featherbed Bank	8/12/98 8/14/98 8/15/98	P	25 29 57 N 25 31 29 N 25 30 01 N	80 14 16 W 80 14 31 W 80 14 16 W	✔	✔ Similar	Variance in measurement locations due to tidal / maneuvering concerns. Measurements made on 8/14/98 were 9389 ft (approximately 1.8 mi) from those made on 8/12 and 8/15/98.
Fender Point	8/11/98 8/14/98 8/14/98	F	25 28 11 N 25 28 09 N 25 28 09 N	80 20 26 W 80 20 26 W 80 20 26 W		✔ Similar	
Mangrove Key	8/11/98 through 8/12/98 8/15/98	H	25 24 12 N 25 24 17 N	80 19 04 W 80 18 54 W	✔		
Pacific Reef	8/11/98 8/16/98	E	25 22 03 N	80 08 54 W	✔	✔ Similar	
Rubicon Key	8/11/98 8/14/98	D	25 23 27 N 25 23 31 N	80 13 58 W 80 14 01 W	✔	✔	
Soldier Key	8/13/98 8/16/98	L	25 35 28 N	80 09 39 W		✔	
Stiltsville	8/12/98 8/16/98	J	25 37 18 N 25 37 17 N	80 08 54 W 80 08 57 W	✔		Variance in measurement locations due to tidal / maneuvering concerns.

Site Name	Date(s)	Site ID	Latitude	Longitude	Boat	NPS	Notes
Stiltsville (cont.)	8/17/98		25 37 45 N	80 12 06 W			Measurements made on 8/17/98 were 17783 ft (approximately 3.4 mi) from those made on 8/12 and 8/16/98.
Visitor Center	8/11/98 8/16/98	G	25 27 52 N	80 20 05 W		✔	
Everglades National Park (ENP)							
Anhinga Trail	8/10/98 8/12/98 8/15/98	B	25 23 01 N	80 36 22 W		✔	
Buchanan Key	8/19/98	Y	24 54 58 N	80 46 29 W	✔		
Chekika	8/10/98 8/17/98	O	25 36 45 N	80 35 04 W			
Eastern Panhandle	8/13/98	M	25 17 16 N	80 26 30 W			
Eastern Sparrow	8/18/98	V	25 29 52 N	80 39 45 W			accessible by helicopter only
Eco Pond	8/14/98	Q	25 08 19 N	80 56 16 W		✔	
Hidden Lake	8/15/98 8/17/98	R	25 22 55 N	80 37 06 W			
Little Madeira Bay	8/18/98 8/20/98	U	25 11 45 N 25 10 53 N	80 37 42 W 80 38 21 W	✔		Variance in measurement locations due to tidal / maneuvering concerns. Measurements made on 8/20/98 were 6355 ft (approximately 1.2 mi) from those made on 8/18/98.
North Nest Key	8/18/98	X	25 09 06 N	80 30 41 W		✔	
Pavilion Key	8/20/98	AA	25 42 31 N	81 21 03 W			
Pinelands	8/12/98 8/13/98 8/19/98	K	25 25 22 N	80 40 47 W		✔ Similar	
Shark Valley	8/13/98 8/16/98	N	25 39 23 N	80 45 59 W			
Whitewater Bay	8/17/98	T	25 14 48 N	80 57 51 W	✔		
Crocodile Lake National Wildlife Refuge (CLK)							
Barnes Sound	8/19/98	AD	25 14 29 N	80 20 03 W	✔		
Hardwood Hammock	8/18/98	W	25 15 56 N	80 18 39 W			

Site Name	Date(s)	Site ID	Latitude	Longitude	Boat	NPS	Notes
Mangrove Inlet	8/18/98 8/18/98	AC	25 13 36 N	80 20 01 W			
Big Cypress National Preserve (BCY)							
Golightly Campground	8/16/98 8/17/98	S	25 45 17 N	80 55 35 W			
National Scenic Trail	8/20/98	AE	25 51 47 N	81 02 06 W			

3. Instrumentation

This section discusses the acoustic and related instrumentation used in the study. For those interested in further detailed information Appendix C presents technical specifications for the acoustic measurement system.

3.1 Microphone, Preamplifier and Windscreen

A microphone transforms sound-pressure variations into electrical signals, that are in turn measured by instruments such as a sound level meter (SLM) or a one-third octave-band analyzer (**spectrum** analyzer), and/or recorded on tape or some other storage medium. The Brüel and Kjær (B&K) Model 4155 and 4189 microphones used in the current study are electret condenser microphones. These microphones utilize a diaphragm of pure nickel, which is coated with a protective quartz film. The microphone backplate is made of a corrosion-resistant high-nickel alloy which carries a negatively charged layer. Such a design allows the microphone to maintain its own polarization, i.e., often referred to as a *pre-polarized* design. Pre-polarization allows the electret microphone to function as a *closed system* with regard to humidity, thus eliminating the potential for condensation in high humidity situations, an obvious concern in southern Florida in August. Additionally, the B&K Model 2671 preamplifier and Model WB 1372 power supply were employed at each site.

A conventional windscreen is a porous sphere [usually made of foam and about 3.5 in (9 cm) in diameter] which is placed atop a microphone to reduce the effects of wind-generated noise on the microphone diaphragm. By reducing the wind-generated noise on the microphone diaphragm, the signal-to-noise (S/N) ratio of a sound measurement is effectively improved. Due to the low sound levels associated with measurements at many of the sites, as well as the anticipated high winds at the water-based sites, a

* Traditional condenser microphones are extremely sensitive to humidity. The conventional condenser design (as opposed to the electret condenser design used in the current study) can result in electrical arching in high humidity environments. Arching will contaminate the measured signal, and can in extreme situations cause damage to the microphone.

conventional windscreen alone did not provide enough of an improvement in the S/N ratio. As part of the development of their "turn-key" Low Noise Monitoring System (LONOMS), the NPS funded the design and development of a tripod-mounted, two-stage windscreen to be used for measurements in the National Parks. The two-stage design, which is documented extensively in Reference 14, consists of a 20 inch diameter (51 cm) fabric-covered outer stage, and a conventional B&K Model UA0207 foam windscreen making up the inner stage. This specially designed two-stage windscreen was used for measurements performed in the current study.

3.2 Sound Level Meter (SLM)

The microphone/preamplifier was connected via 300 ft. (91.4 m) of cable (50 ft. or 15.2 m of cable for measurements made on-board a boat) to a Larson Davis Laboratories (LDL) Model 820 sound level meter (SLM). The Model 820 is a Type 1 SLM which performs true numeric integration and averaging in accordance with ANSI S1.4-1983.[15] It was set up to continuously measure and store at one-second time intervals the **equivalent sound level (1sEQ, denoted by the symbol $L_{Aeq,1s}$)** as well as the **maximum A-weighted sound level with slow exponential time weighting (MXSA, denoted by the symbol L_{ASmx})**. In this mode the Model 820 is capable of storing over 18 hours of uninterrupted data.

The use of 300 ft. of extension cable (at the land-based sites) ensured that field personnel could move about and conduct whispered conversations without influencing the measured sound. Extreme care was taken at the water-based sites to be still and quiet during measurements.

Slow exponential time weighting, as compared with fast or impulsive time weighting, was utilized for three reasons: (1) consistency with previous NPS measurements [6,7,9] (although in some previous NPS and USAF studies[16,17] the L_{ASmx} was actually approximated by using the maximum $L_{Aeq,1s}$ measured during a particular time period, any associated differences as compared with the true L_{ASmx}

measured in the current study are expected to be small and most likely negligible); (2) consistency with most aircraft noise measurement studies; and (3) the likelihood of slow response to ***systematically*** and ***predictably*** reduce the impulsive sounds of nature, e.g., bird chirps, insects, etc. It was considered beneficial to reduce these impulsive sounds in that: (1) they are generally considered to be unobtrusive, if not pleasant sounds; and (2) by minimizing their potentially contaminating effect, it is more likely that statistically representative measurements could be obtained.

3.3 Digital Audio Tape (DAT) Recorder

The AC output of the Model 820 SLM was connected directly to the input of either a Sony Model PC208Ax or Model TCD-D100 digital audio tape (DAT) recorder. The Model PC208Ax DAT recorder was set up to operate at single speed in a two-channel recording mode. At single speed, the 295-ft. (90-m) tapes were capable of providing slightly more than 3 hours of recording time. The Model TCD-D100 DAT offers a half-speed recording mode, which provided about 4 hours of recording time with the 197-ft. (60-m) tape.

The decision to use a DAT recorder as opposed to a portable one-third octave-band analyzer was made primarily because the actual purpose of measuring frequency-based data was not entirely known prior to measurements, and tape recording allows for repeated playback and analysis, including the option for narrow-band analysis, if deemed necessary.

3.4 Acoustic Observer Log

An acoustic observer log was maintained to provide a continuous, timed record of **audible** sounds throughout the measurement period. An automated Microsoft Excel spreadsheet was used to perform the logging. The spreadsheet, displayed in Figure 16, offered a substantial advantage over a manual

logging system in that it produced an electronic file which was used in data reduction immediately following field measurements. A further advantage of the automated spreadsheet was that it offered the ability to quickly "click" on buttons using a traditional mouse, as well as "hot-key" entry of menu items and keyboard entry of text. The obvious disadvantages of the spreadsheet method were the bulk and battery power requirements for the supporting laptop computer. As a backup to the automated log, the manual log sheet shown in Figure 17 was available in the field should the automated system have failed for some reason.

3.5 Meteorological Instrumentation

In addition to the acoustical instrumentation, a Qualimetrics Transportable Automated Meteorological Station (TAMS) was set up to measure temperature, relative humidity, wind speed and direction, and ambient atmospheric pressure at one-second intervals. The use of one-second time intervals allowed for direct correlation between the sampled acoustical and meteorological data.

3.6 Other Instrumentation

A B&K Model 4231 sound calibrator was used in the field for establishing and checking the sensitivity of the entire acoustic instrumentation system (i.e., microphone, preamplifier, cables, SLM, and DAT). The Model 4231 produces a user-selectable 94 **dB sound pressure level** at a frequency of 1 kHz.

Time synchronization of all pertinent instrumentation in the measurement chain was performed with a single digital watch (master clock). In particular, the SLM, DAT, acoustic observer log and meteorological instrumentation were synchronized to the master clock each day to facilitate accurate data reduction and analysis. To ensure synchronicity between different measurement teams, each team would set its master clock on a daily basis according to Universal Coordinated Time (UTC).

It is also important to point out that the radar tracking system at Miami International Airport (MIA) is synchronized to UTC, thus easily facilitating the coordination of acoustical, meteorological and flight track data if deemed necessary.

At the land-based sites, a hand-held Motorola Radius GP300 FM radio was utilized for communication between personnel during setup and breakdown of the instrumentation.

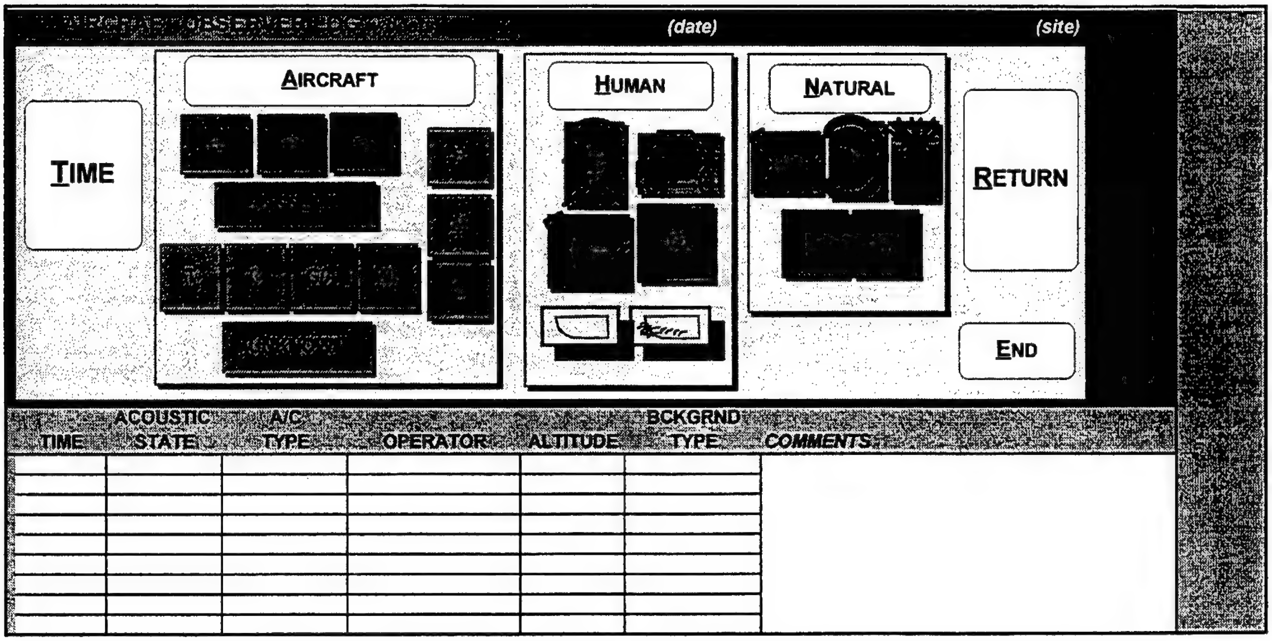


Figure 16. Automated Acoustic Observer Log

Manual Aircraft Observer Log w/ Boats

Date: _______ **Site:** ______________________ **Page:** ____ **of** ___

TIME	AIRCRAFT												HUMAN						NATURAL					COMMENTS
					SUB-TYPE					ALTITUDE														
	HELI	PROP	JET	UNK	TOUR	COMM	G/A	MIL	UNK	HIGH	MED	LOW	AUTO	HUMAN	PET	BOAT	WAVES/BOAT	OTHER	ANIMAL	WIND/TREE	WIND/EAR	WATER	OTHER	

Figure 17. Manual Acoustic Observer Log

4. Field Measurement Procedures

With the exception of the limited amount of planned nighttime measurements, the goal each day was to commence with data collection as close as possible to 0700. Allowing three hours for measurements, 1 to 1.5 hours for breakdown, travel to a second site and setup at the site, and 3 additional hours for measurements at the second site, each team would ideally be done with measurements on a given day by 1430 -- hopefully before any afternoon precipitation. This rather aggressive schedule was often not practical, due primarily to the longer than anticipated travel times between sites, as well as the somewhat unpredictable weather patterns. The conclusion of a more typical measurement day occurred sometime between 1600 and 1800. The remainder of this section describes the specific field measurement procedures employed upon arrival at a measurement site.

4.1 Personnel Requirements

Due to the large amount of targeted measurement sites and a rather narrow 10-day window of opportunity for the measurements, three two-person teams were established to conduct the field study. At each measurement site, one individual continuously logged the changes in the acoustic state. The second individual monitored the SLM, the DAT recorder, and the meteorological system. Individuals rotated duties throughout a typical measurement.

Prior to commencement of the study, individuals were tested to ensure consistent, accurate hearing. This was accomplished by conducting outdoor tests, during which personnel simultaneously logged acoustic states as they would during actual measurements. The results of these tests were compared to ensure that team members were capable of consistently and accurately performing the logging activity. For further assurance, a similar activity was randomly conducted in the field during which team members periodically performed manual logging of acoustic states while the automated observer log was being maintained by another team member. In the case of both tests, small variations between observers were documented. These variations were on the order of just a few seconds and were random in nature, and as such considered negligible.

Further, a post-measurement listening test was conducted. During this test, team members listened via headphone to actual tape-recorded data from the field. While listening they developed an acoustic observer log (see Section 3.4). Each log, and accompanying data were reduced (see Section 5) and resultant ambient sound levels computed. These ambient levels were compared with those computed using the observer logs developed in the field. In all cases, the largest difference in ambient sound level was less than 0.1 dB.

4.2 Measurement System Setup

Following is a step-by-step description of the acoustic system setup which took place each day upon arrival at a typical measurement site:

(1) The microphone, preamplifier, and windscreen were attached to a tripod which was positioned in a location considered typical of the surrounding ambient environment, i.e., away from any known localized noise sources (Microphone Location). The tripod was adjusted to locate the microphone diaphragm at a height of 5 ft. (1.5 m) directly above the local ground surface, oriented vertically (microphone grid facing the sky). Note: In the case of water-based measurements, the microphone/preamplifier/windscreen were placed on the bow of the boat, 5 ft. above the deck. To ensure physical stability, the entire system was secured to the boat using a bungee chord arrangement, or using nylon rope with tension adjusters. Figures 18 and 19 show the microphone/preamplifier/windscreen arrangement as it was deployed at a typical land-based and water-based site, respectively.

(2) The SLM, DAT, and acoustic data logging instrumentation were positioned in full view of the microphone location, but at a distance of approximately 300 ft. (91.4 m), 20 ft. (6.1 m) in the case of a water-based site (Observer Location). Figures 20 and 21 show the acoustic observer location setup as it was deployed at a typical land-based and water-based site, respectively.

(3) The meteorological instrumentation was positioned at a location approximately 50 ft. (15.2 m) from the observer location (or 5 ft. for water based measurements), and some 250 ft. (76.2 m)

from the Microphone Location (or 25 ft. for water-based measurements), but in a position still representative of the wind conditions at the Microphone Location. The separation distance between the meteorological instrumentation and the Microphone Location was maintained so that personnel could make periodic checks of meteorological measurements and power supply status without influencing the acoustical measurements. The meteorological sensors were placed at a height of 5 ft. (1.5 m) directly above the local ground surface or the boat deck, as appropriate. Like the microphone, the meteorological instrumentation was positioned in an open area representative of the surrounding environment. Figure 22 shows the TAMS system as it was deployed at a typical measurement site in the field.

(4) A total of 300 ft. (91.4 m) of cable (50 ft. in the case of the water-based sites) was connected between the instrumentation at the microphone location and at the observer location, and all instrumentation was then powered up.

(5) The next step was to establish that the internal clocks of all pertinent instrumentation (namely the SLM, DAT, meteorological system and laptop) were set to the time of the master clock.

(6) With all electrical components of the acoustic measurement system connected, a preliminary sound level calibration of the system was performed. The purpose of the preliminary calibration was to ensure that all equipment was operating properly.

(7) The electronic noise floor of the entire electrical system absent of the microphone was established, using a non-transducive (i.e., mechanically passive) capacitive load.

(8) After re-installation of the microphone, a pre-measurement sound level calibration of the system was performed.

(9) The two-stage windscreen was then deployed and the preamplifier cable secured to a leg of the tripod, to prevent vibration. All other cables were "dressed" to allow for easy visual inspection, and to prevent disturbance by site activity.

(10) Ambient sound level measurements (SLM), sound recordings (DAT), meteorological measurements, and logging of the acoustic environment were then initiated.

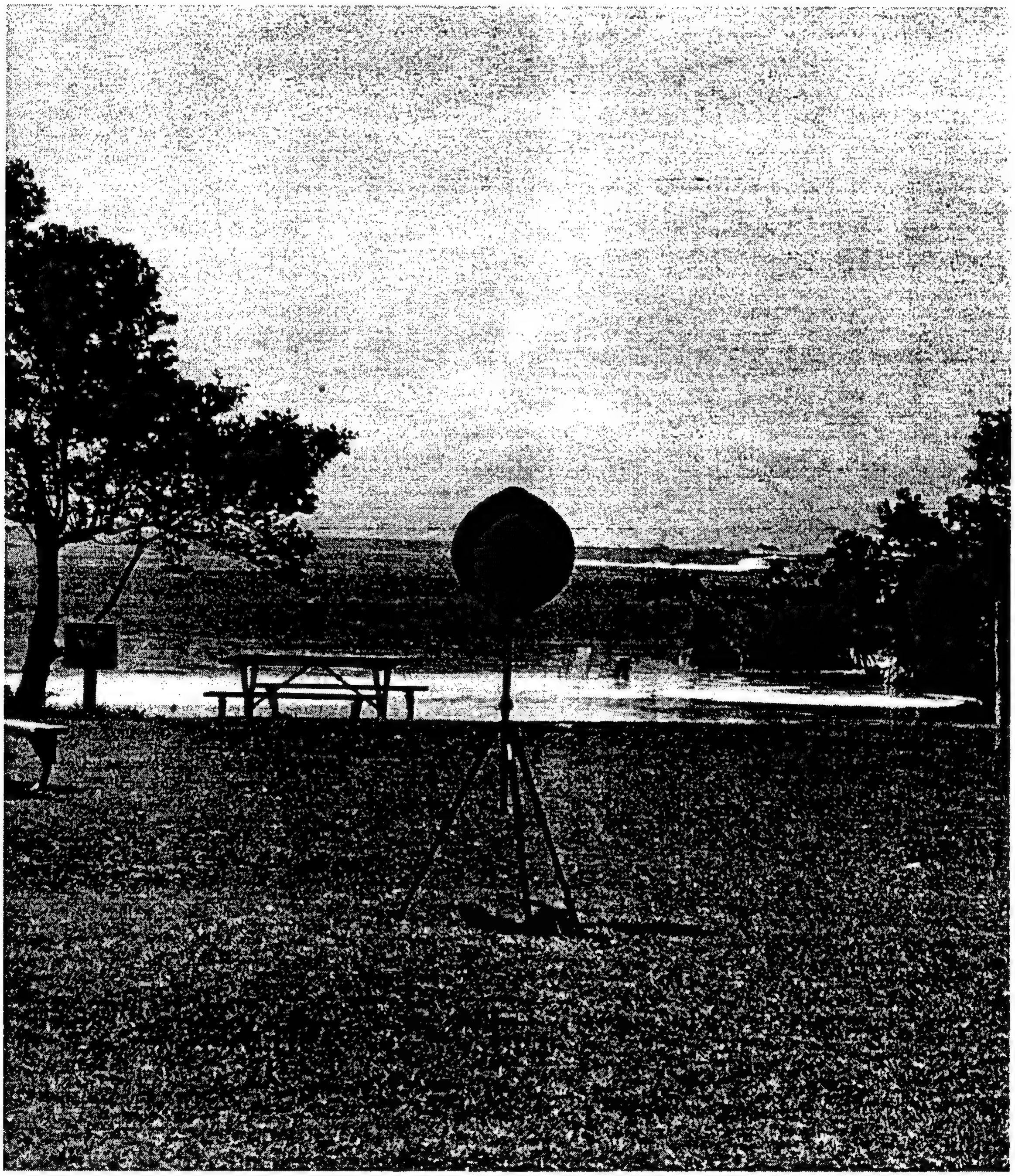


Figure 18. Land-Based Microphone/Preamplifier/Windscreen Arrangement

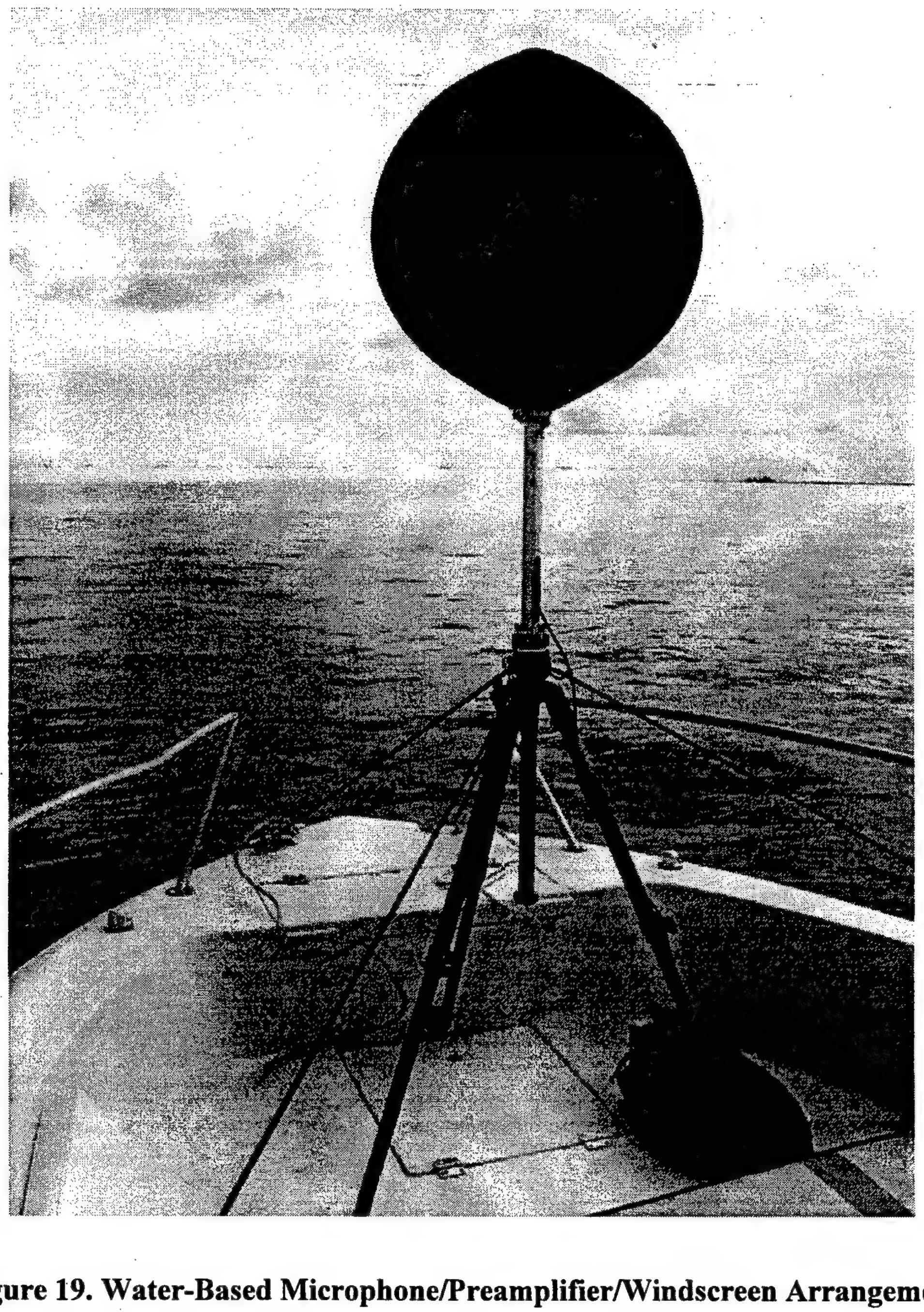


Figure 19. Water-Based Microphone/Preamplifier/Windscreen Arrangement

Figure 20. Land-Based Acoustic Observer Location

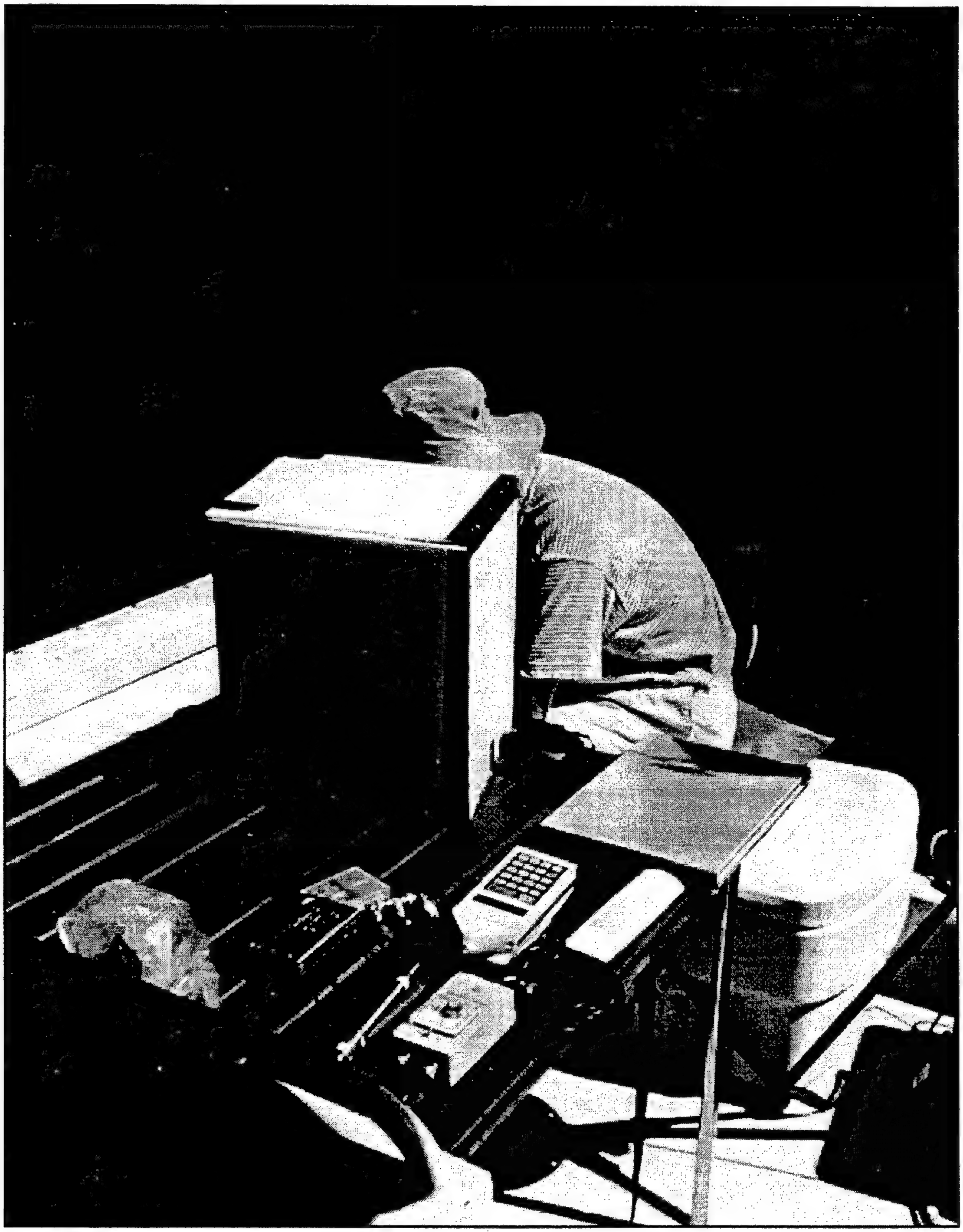


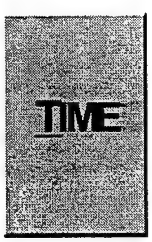
Figure 21. Water-Based Acoustic Observer Location

Figure 22. TAMS System

4.3 Measurements

During measurements, the field observer continuously documented the acoustic environment at the site. In performing this activity, the acoustic environment was divided into three primary categories: (1) *Aircraft*; (2) *Non-Aircraft - Human*; and (3) *Natural*. These categories were arranged into a hierarchy, with *Aircraft* taking the highest priority; *Non-Aircraft - Human* taking second; and *Natural* taking third. This hierarchy allowed the observer in the field to select one category if several were applicable simultaneously. Thus, if an aircraft and an automobile were audible simultaneously, the *Aircraft* category was documented. If a automobile and a bird were simultaneously audible, the *Non-Aircraft - Human* category was documented. The *Natural* category was documented when no human-made sounds of any kind were audible. No human judgement was made as to which sound was "acoustically dominant" -- the hierarchy was conformed to in the strictest sense. A particular category remained the documented category until a change in the acoustic state was audible to the observer.

The actual logging instrument was the automated spreadsheet depicted in Figure 16. In addition to the three primary acoustic categories, there are several subcategories. The spreadsheet inputs, including primary categories and associated subcategories are described in detail below:



: designates the exact time associated with a change of state in the current acoustic environment. Use of this input initiated a new entry in the spreadsheet, the specific details of which could be input as they became apparent to the observer. The availability of this input allowed for immediate identification of a change in the acoustic environment.

: designates *Aircraft* state. Note: The types of aircraft are presented in a hierarchal order. For example, if both a helicopter and a propeller-type aircraft were simultaneously audible, the helicopter was documented.

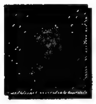
: designates Helicopter-type aircraft.

: designates Propeller-type aircraft.

: designates Jet-type aircraft.

: designates Unknown-type aircraft (invoked primarily for aircraft which were heard but not seen).

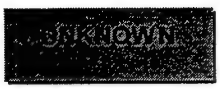
: designates Tour operator.



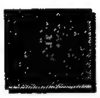
: designates Commercial operator.

: designates General Aviation operator.

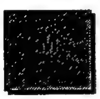
: designates Military operator.



: designates Unknown operator (invoked primarily for aircraft which were heard but not seen).

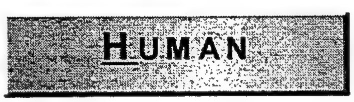


: designates high altitude aircraft.



: designates medium altitude aircraft.

: designates low altitude aircraft.



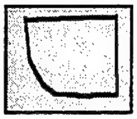
: designates *Non-Aircraft - Human* state.

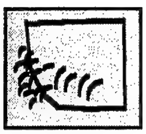
: designates noise produced by automobiles.

: designates noise produced directly by humans, e.g., voices.

: designates noise produced by pets, e.g., dog barking.

: designates noise produced by other human-induced sources.

 : designates noise produced by boats.

 : designates noise produced by "waves against the hull" of the measurement boat.

NATURAL : designates *Natural* state.

 : designates noise produced by wildlife, e.g., birds.

 : designates noise as "wind-in-the-foliage."

 : designates noise as "wind-in-the-ear."

 : designates noise produced by water sources.

 : designates noise produced by other natural sources.

: returns active cell to beginning of next spreadsheet line in preparation for next acoustic state.

Depending upon the time of day and associated dynamics of the sound environment, the acoustic team found maintenance of the observer log to be an extremely tedious task in the field, and one that required frequent breaks. During measurements, the goal was to rotate logging personnel hourly to maintain the necessary level of alertness.

As mentioned previously, at various times throughout the measurement period, individuals not performing the "official" logging activity occasionally conducted "unofficial" logging for the purpose of determining consistency among different loggers.

In addition, periodic checks were performed on both the acoustical and meteorological instrumentation for the following: available battery power, remaining internal memory for devices with internal data storage (SLM and meteorological system), and remaining tape in the case of the DAT recorder.

4.4 Measurement System Dismantling

Following is a step-by-step description of the system dismantling which took place upon completion of measurements:

(1) A post-measurement sound level calibration of the entire acoustical system was performed and any drift from the initial calibration was documented.

(2) The internal clocks of the SLM, DAT, meteorological system and laptop were compared with the master clock and any time drift was documented.

(3) All instrumentation was powered down and the entire system was disconnected and stored.

Prior to data reduction (see Section 5), the stored sound level data in the Model 820 SLM were downloaded to a laptop computer and the LDL binary files converted to comma-delimited ASCII text files. The acoustic observer log was initially saved in Microsoft Excel spreadsheet format and later converted to ASCII format. The meteorological data were saved in a comma-delimited ASCII text file.

5. Data Reduction

Figure 23 presents a flow diagram of the data reduction process. Essentially, there were two primary data sets, the acoustical data and the meteorological data. The acoustical data consisted of the contiguous one-second sound levels (both $L_{Aeq,1s}$ and L_{ASmx}), in addition to the acoustic observer data. The meteorological data, after reformatting via the TAMS program, consisted of one-second samples of temperature, relative humidity, wind speed, wind direction and ambient atmospheric pressure. For the purposes of the current study, wind speed was the primary meteorological variable examined, although some cursory analyses of wind direction data were also performed. The sound level data, the acoustic observer data, and wind speed data were used by the Volpe Center as inputs to its ambient data processing program entitled AMBIAVG. The remainder of this section presents the specifics of the data reduction process employed in the current study.

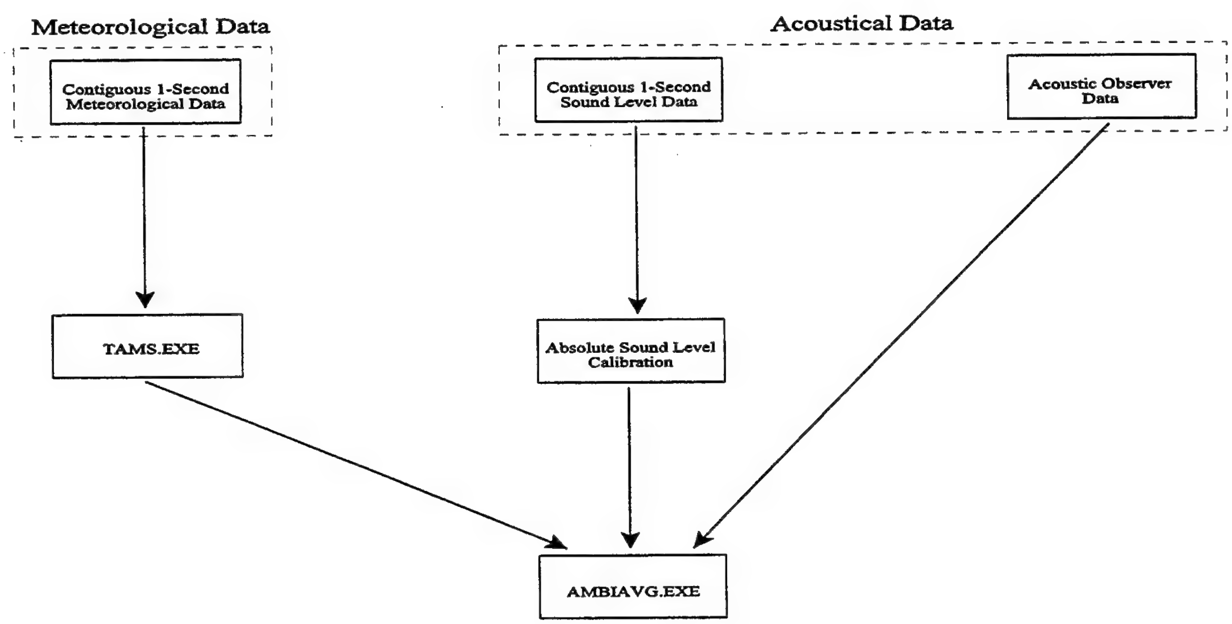


Figure 23. Flow Diagram of Data Reduction Process

5.1 Data Cleaning and Editing

Backup copies of all data files were made daily. The naming scheme for the data files was as follows: "MDDYYaai," where "M" is a one-digit representation for the month, "DD" is a two-digit representation for the day of the month, "YY" is a two-digit representation of the year, "aa" is a unique character ID representing the site and "i" is an increment used when multiple files were required on a given day at the same site. Unique file extensions were given to different types of data.

5.1.1 Raw Acoustic Data

No editing was required for the acoustic data, which existed as ASCII text files, prior to running AMBIAVG. A separate file containing calibration and time data was created using a text editor. This file contained any adjustments required for calibration drift as well as start and end time-of-day for all files.

5.1.2 Acoustic Observer Log Data

The acoustic observer log data files were checked daily for accuracy and edited as necessary. Editing generally consisted of clarifying comments. Occasionally, inconsistent data entries had to be deleted. The spreadsheet files were then translated to comma-delimited ASCII format for input into AMBIAVG.

5.1.3 Meteorological Data

Prior to processing, the meteorological data were run through a preprocessor called TAMS which checked for dropouts (missing records for a given one-second time period). Less than twenty dropouts, generally one record (one second) in length, were encountered on any given day. Data for dropouts were simply copied from the record immediately preceding the dropout. It should be noted that, with the exceptions of measurements made at Buchanan Key and Little Madeira Bay, it was not necessary to correct for dropouts of any meteorological data at or near wind speeds of 15 mph -- the

predetermined wind-speed acceptability threshold (see Section 5.4). The output from TAMS was then used by AMBIAVG.

5.2 Ambient Sound Level Definitions

The term "ambient noise" can have different meaning depending upon the specific application. To avoid confusion, this document follows the precedent of *Draft Guidelines for the Measurement and Assessment of Low-Level Noise*[5] in using the following definitions for ambient noise:

Existing Ambient: The composite, all-inclusive sound associated with a given environment, excluding only the analysis system's electrical noise. Aircraft noise *is* included.

Traditional Ambient: The composite, all-inclusive sound associated with a given environment, excluding the analysis system's electrical noise and the sound source of interest, which in this case is aircraft. In effect, traditional ambient is the existing ambient, excluding aircraft.

Natural plus Visitor Self-Noise (N+VSN): As defined by the NPS in the 1995 Report to Congress, the natural sound conditions found in a study area, including all sounds of nature (i.e., wind, streams, wildlife, etc.) *and* visitor-generated self-noise, excluding all mechanical sounds and the analysis system's electrical noise.[18] Visitor self-noise includes voices, footsteps and other sounds that a visitor creates.

Natural Ambient: The natural sound conditions found in a study area, including all sounds of nature (i.e., wind, streams, wildlife, etc.), excluding all human and mechanical sounds as well as the analysis system's electrical noise (i.e., *only* the sounds of nature).

5.3 Computing Ambient Sound Levels

For each site on a given measurement day, four ambient sound level values, based on the four ambient definitions presented in Section 5.2, were computed by AMBIAVG. Specifically, the data in the

acoustic observer log were used to group the individual one-second sound level values according to the appropriate ambient definition. Individual one-second values grouped within a given ambient definition were then combined to compute a single ambient sound level value according to the following equation:

$$L_{Aeq} = 10 \times \log_{10}(\sum 10^{(L_{Aeq,1s} \div 10)}) - 10 \times \log_{10}(DUR)$$

where: $L_{Aeq,1s}$ represents each 1-second L_{Aeq} from the appropriate type of ambient;

DUR represents the duration in seconds for a particular ambient type.

Occasionally, sound level data were collected during multiple measurement periods at a given site on a single day. This usually occurred when measurements at a given site were interrupted as a result of some external variable, e.g., precipitation. In such instances, ambient sound levels from separate periods were combined according to the following equation:

$$L_{Aeq,COMB} = 10 \times \log_{10} \sum (10^{(L_{Aeq1} \div 10)} \times \frac{DUR1}{DUR1 + DUR2} + 10^{(L_{Aeq2} \div 10)} \times \frac{DUR2}{DUR1 + DUR2})$$

where: L_{Aeq1} represents the L_{Aeq} for a particular ambient type for the first measurement period at a given site on a particular day;

L_{Aeq2} represents the L_{Aeq} for a particular ambient type for the second measurement period at a given site on a particular day; DUR1 represents the duration in seconds for a particular

ambient type for the first measurement period at a given site on a particular day; and

DUR2 represents the duration in seconds for a particular ambient type for the second measurement period at a given site on a particular day.

Finally, the sound level data obtained at sites which had multiple measurement days were combined. In doing so, the following equation which weights more heavily data collected on weekdays as opposed to data collected on weekends (5/7 and 2/7, respectively, in terms of **acoustic energy**) was employed so as to more appropriately represent an ambient value for the so-called "average day". For sites which had multiple measurement days, none of which were on the weekend, the 5/7 and 2/7 weighting factors were not used. In other words, in the following equation the five and two were set to unity.

$$L_{Aeq,FINAL} = 10\times\log_{10}\sum [5\times 10^{(L_{AeqWkDay}\div 10)}\times\frac{5\times DUR_{WkDay}}{(5\times DUR_{WkDay})+(2\times DUR_{WkEnd})} + 2\times 10^{(L_{AeqWkEnd}\div 10)}\times\frac{2\times DUR_{WkEnd}}{(5\times DUR_{WkDay})+(2\times DUR_{WkEnd})}]$$

where: $L_{AeqWkDay}$ represents the L_{Aeq} for a particular ambient type for a given site measured during the week, i.e., Monday through Friday;

$L_{AeqWkEnd}$ represents the L_{Aeq} for a particular ambient type for a given site measured on the weekend, i.e., Saturday or Sunday;

DUR_{WkDay} represents the duration in seconds associated with $L_{AeqWkDay}$; and

DUR_{WkEnd} represents the duration in seconds associated with $L_{AeqWkEnd}$.

5.4 Computing Average Wind Speed and Wind Effect

Average wind speed and "wind effect" were calculated for each ambient type during each measurement period. The average wind speed is simply the linear average of all one-second wind speed measurements associated with a given type of ambient. Wind effect, or the effect wind speed had on the particular ambient sound level, was calculated using ten-second energy-averaged L_{Aeq} values and their associated ten-second linearly averaged wind speeds. Plots were derived illustrating the relationship between L_{Aeq} and wind speed.

In most cases, the wind effect behaved in a linear fashion over the range of measured data. The actual wind effect is defined as the slope (in decibels per mile per hour) of a linear regression fitted to the L_{Aeq} and wind speed data. The average wind speed and wind effect for sites with multiple measurement periods were often combined to arrive at values representing all the data from a single site (see discussion in Section 6.1).

It was initially intended that acoustic data measured for wind speeds above 15 mph would be excluded from all averages. However, further analyses of tape-recorded data indicated that this was unnecessary. Ultimately, some 450 seconds of acoustic data were excluded from the average at the Buchanan Key site due to sustained wind conditions over 20 mph during that period (see further discussion in Section 6.4.2).

6. Results

This section presents a detailed discussion of the results of the study. Included is a summary of all the measured data (Section 6.1), a discussion of the rationale for selecting the traditional ambient sound level for the Homestead SEIS (Section 6.2), followed by a discussion of the data on a site-by-site basis (Sections 6.3 through 6.6 for each of the four conservation units, respectively), a discussion of NPS meteorological data (Section 6.7), a comparison with previously measured ambient sound level data (Section 6.8), and the traditional ambient sound level maps developed in support of this study (Section 6.9).

6.1 Summary

Table 4 contains a summary of the ambient sound level data measured at the four conservation units. It is arranged by unit, with the data for BNP first, followed by the data for ENP, CLK, and BCY. Within each unit the individual measurement sites are arranged alphabetically by name. For some sites, data are presented for as many as three individual measurement periods. Along with the data for the individual period, a single set of ambient sound levels is presented for each site. This set was computed using the methodology outlined in Section 5.3. Namely, data from individual days were combined using a simple logarithmic average, and if measurements at a particular site were conducted on the weekend, an appropriate 5/7 and 2/7 weighting was applied during the logarithmic averaging process. The first seven columns in Table 4 are arranged as follows:

Date: The date the measurements were made.

Start Time: The start time-of-day of the measurements.

Duration: The duration in hours and minutes of the particular measurement.

Site ID: An internal Volpe Center designator, included for consistency with field data logs.

Site Name: The name assigned to the measurement site.

***Lat/Lon*:** The latitude/longitude measured at the site using a GPS receiver (WGS-84 reference).

$\%T_{AC}$: The percentage of measurement time aircraft were audible (Figure 24 presents without further discussion a more concise summary of this data.)

The next four primary columns define the particular type of ambient represented by the data: Traditional, Existing, Natural, and Natural plus Visitor Self-Noise (N+VSN), as defined in Section 5.2. Then, for each type of ambient the following data are presented:

L_{Aeq}: The equivalent A-weighted sound level (in decibels). Presented is the energy-average value representing the entire measurement period, and the contiguous 10-second energy average minimum and maximum sound levels.

***DUR*:** The duration in seconds of the measurement.

***%T*:** The percentage of measurement time the particular ambient represents. No value is presented for Existing, since it is always 100 %.

***W/S*:** The wind speed. Presented is the linearly averaged value representing the entire measurement period, and the contiguous 10-second average minimum and maximum values.

***W/E*:** The wind effect. In other words, decibels per mile per hour change in wind speed. For example, a W/E of 0.95 means that for each mile per hour change in wind speed the decibel value increases by 0.95 dB. In the majority of cases, the wind speed range for a given measurement period was not large enough to calculate a meaningful wind effect on a period-by-period basis. Therefore, data from separate days at a given site were combined to calculate a single wind effect for the site. In general, the wind

Table 4. Summary of Measured Ambient Sound Level Data

Date	Start Time	Duration (Hr:Min)	Site ID	Site Name	Lat. / Long.	$\%TA_{AC}$	Traditional						Existing					Natural						Natural plus Visitor Self-Noise (N+VSN)					
								L_{Aeq} (dB)	DUR (s)	%T (%)	WS (mph)	WE (dB/mph)		L_{Aeq} (dB)	DUR (s)	WS (mph)	WE (dB/mph)		L_{Aeq} (dB)	DUR (s)	%T (%)	WS (mph)	WE (dB/mph)		L_{Aeq} (dB)	DUR (s)	%T (%)	WS (mph)	WE (dB/mph)
BISCAYNE NATIONAL PARK																													
					25 31 47 N		Avg	51.8			7.9		Avg	54.6		8.1		Avg	51.3			9.3		Avg	51.2			8.3	
8/10/98	8:02:53	2:27	A	Black Point	80 17 57 W	22.7	Min	48.3	6863	77.3	2.5	0.20	Min	48.3	8878	1.8	0.19	Min	51.0	24	0.3	8.3	(NA)	Min	49.0	318	3.6	6.3	-0.16
							Max	61.2			13		Max	71.7		13.2		Max	51.3			10.1		Max	52.8			10.3	
					25 32 4 N		Avg	50.7			6.4		Avg	51.4		6.7		Avg	(NA)			(NA)		Avg	50.9			9.4	
8/12/98	21:03:25	2:57	A	Black Point	80 18 1 W	21.3	Min	49.6	8336	78.7	0	0.97	Min	40.5	10594	0	1.09	Min	(NA)	0	0.0	(NA)	(NA)	Min	48.4	68	0.6	0.0	0.75
							Max	72.5			13.4		Max	72.5		13.4		Max	(NA)			(NA)		Max	52.4			12.1	
							Avg	51.8			7.9		Avg	54.6		8.1		Avg	51.3			9.3		Avg	51.2			8.3	
BLACK POINT			A			22.7	Min	48.3	6863	77.3	2.5	0.20	Min	48.3	8878	1.8	0.19	Min	51.0	24	0.3	8.3	(NA)	Min	49.0	318	3.6	6.3	-0.16
							Max	61.2			13		Max	71.7		13.2		Max	51.3			10.1		Max	52.8			10.3	
					25 31 28 N		Avg	47.2			7.1		Avg	47.6		7.2		Avg	42.0			7.3		Avg	41.2			7.1	
8/10/98	12:13:13	2:46	C	Boca Chita	80 10 33 W	45.8	Min	28.3	5419	54.2	4	0.86	Min	28.3	9993	3.8	0.95	Min	29.5	1677	16.8	4	1.55	Min	28.3	2517	25.2	4.0	1.33
							Max	68.1			11.4		Max	68.1		11.4		Max	52.4			10.7		Max	52.4			10.7	
					25 31 28 N		Avg	46.4			4.7		Avg	49.5		4.4		Avg	41.9			4.7		Avg	42.0			4.6	
8/13/98	15:01:42	2:47	C	Boca Chita	80 10 33 W	53.4	Min	29.2	4679	46.6	0	1.95	Min	29.2	10031	0	0.57	Min	29.2	1874	18.7	2	1.26	Min	29.2	2251	22.4	1.3	1.14
							Max	62.1			9		Max	67.0		9		Max	51.0			8.7		Max	51.3			8.7	
					25 31 28 N		Avg	52.0			5.1		Avg	55.0		5.1		Avg	(NA)			(NA)		Avg	48.7			4.7	
8/15/98	12:13:25	2:59	C	Boca Chita	80 10 33 W	33.2	Min	38.1	7182	66.8	0	0.86	Min	38.1	10755	0	0.76	Min	(NA)	0	0.0	(NA)	(NA)	Min	40.0	1198	11.1	0.0	0.80
							Max	62.2			9.2		Max	70.0		9.2		Max	(NA)			(NA)		Max	55.8			8.7	
							Avg	48.6			5.8		Avg	50.7		5.7		Avg	41.9			5.9		Avg	43.0			5.8	
BOCA CHITA			C			43.9	Min	28.3	17280	56.1	0	-0.06	Min	28.3	30779	0	-0.33	Min	29.2	3551	11.5	2	0.15	Min	28.3	5966	19.4	0.0	-0.45
							Max	68.1			11.4		Max	70.0		11.4		Max	52.4			10.7		Max	55.8			10.7	
					25 27 14 N		Avg	44.1			3.6		Avg	46.1		3.4		Avg	49.2			3.5		Avg	47.7			3.6	
8/12/98	9:34:59	3:02	I	Elliott Key	80 11 45 W	53.2	Min	26.3	5109	46.8	0	0.41	Min	26.3	10920	0	0.00	Min	28.3	1397	12.8	0	0.59	Min	28.3	2087	19.1	0.0	-0.21
							Max	60.1			10.7		Max	65.3		10.7		Max	60.1			8.5		Max	62.1			8.5	
					25 27 14 N		Avg	53.8			3.2		Avg	53.6		3.3		Avg	58.0			2.9		Avg	47.7			3.2	
8/15/98	14:13:28	2:57	I	Elliott Key	80 11 45 W	23.7	Min	32.5	8052	76.3	0	0.31	Min	32.5	10553	0	0.38	Min	33.9	228	2.2	0	-0.68	Min	32.5	6388	60.5	0.0	0.31
							Max	70.1			8.5		Max	73.9		8.5		Max	63.6			6.7		Max	63.6			8.5	
					25 27 14 N		Avg	47.2			3.1		Avg	48.2		3.1		Avg	56.4			3.1		Avg	56.4			3.1	
8/17/98	13:26:53	2:59	I	Elliott Key	80 11 45 W	41.4	Min	28.4	6342	58.6	0	-0.40	Min	28.4	10823	0	-0.27	Min	30.7	706	6.5	0	-2.03	Min	30.7	706	6.5	0.0	-2.03
							Max	65.1			7.6		Max	65.3		8.1		Max	65.1			6.5		Max	65.1			6.5	
							Avg	49.3			3.3		Avg	49.1		3.3		Avg	51.8			3.3		Avg	50.4			3.3	
ELLIOTT KEY			I			39.6	Min	26.3	19503	60.4	0	0.07	Min	26.3	32296	0	0.02	Min	28.3	2331	7.2	0	-0.45	Min	28.3	9181	28.4	0.0	-0.10
							Max	70.1			10.7		Max	73.9		10.7		Max	65.1			8.5		Max	65.1			8.5	
					25 29 57 N		Avg	49.8			5.4		Avg	50.1		5		Avg	(NA)			(NA)		Avg	50.9			8.1	
8/12/98	14:01:21	2:59	P	Featherbed Bank	80 14 16 W	31.4	Min	36.2	7399	68.6	0	0.66	Min	36.2	10790	0	0.52	Min	(NA)	0	0	(NA)	(NA)	Min	48.5	80	0.7	0.0	-0.96
							Max	57.5			10.3		Max	61.0		11.2		Max	(NA)			(NA)		Max	52.6			9.4	
					25 31 29 N		Avg	47.0			4.6		Avg	47.5		4.3		Avg	40.2			6.2		Avg	53.9			5.8	
8/14/98	8:02:29	2:53	P	Featherbed Bank	80 14 31 W	52.6	Min	21.4	4928	47.4	0	2.31	Min	21.4	10391	0	0.10	Min	23.7	100	1.0	5.4	-2.82	Min	23.7	810	7.8	5.4	-2.86
							Max	64.2			7.8		Max	65.1		7.8		Max	49.5			6.9		Max	64.2			6.9	
					25 30 1 N		Avg	48.5			2.7		Avg	48.5		2.7		Avg	(NA)			(NA)		Avg	(NA)			(NA)	
8/15/98	9:41:43	2:55	P	Featherbed Bank	80 14 16 W	24.6	Min	23.3	7949	75.4	0	0.27	Min	23.3	10549	0	0.30	Min	(NA)	0	0	(NA)	(NA)	Min	(NA)	0	0	(NA)	(NA)
							Max	68.4			8.1		Max	68.4		8.1		Max	(NA)			(NA)		Max	(NA)			(NA)	
							Avg	48.8			4.6		Avg	48.9		4.3		Avg	40.2			6.2		Avg	54.0			6.0	
FEATHERBED BANK			P			36.1	Min	21.4	20276	63.9	0	1.08	Min	21.4	31730	0	0.90	Min	23.7	100	0.3	5.4	-2.82	Min	23.7	890	2.8	0.0	-1.13
							Max	68.4			10.3		Max	68.4		11.2		Max	49.5			6.9		Max	64.2			9.4	

Notes:
1. Data measured during the nighttime (Black Point and Mangrove Key) were not included in the overall average.
2. With the exception of Buchanan Key, (see Section 6.3.2), data were not filtered for wind speed, i.e., data were included regardless of wind speed.
3. (*) designates no meteorological data available. Field observer noted wind speeds less than 5 mph.

Table 4. Summary of Measured Ambient Sound Level Data (cont.)

Date	Start Time	Duration (Hr:Min)	Site ID	Site Name	Lat. / Long.	%TAAC	Traditional	L_{Aeq} (dB)	DUR (s)	%T (%)	WS (mph)	WE (dB/mph)	Existing	L_{Aeq} (dB)	DUR (s)	WS (mph)	WE (dB/mph)	Natural	L_{Aeq} (dB)	DUR (s)	%T (%)	WS (mph)	WE (dB/mph)	Natural plus Visitor Self-Noise (N+VSN)	L_{Aeq} (dB)	DUR (s)	%T (%)	WS (mph)	WE (dB/mph)
					25 28 11 N		Avg	41.1			2.6		Avg	48.4		2.8		Avg	42.2			2.7		Avg	42.2			2.7	
8/11/98	7:18:48	3:01	F	Fender Point	80 20 26 W	41.1	Min	27.3	6418	58.9	0	0.62	Min	27.0	10894	0	0.37	Min	27.3	3905	35.8	0	1.45	Min	27.3	3905	35.8	0.0	1.45
							Max	63.0			6.5		Max	68.9		6.9		Max	63.0			6.5		Max	63.0			6.5	
					25 28 9 N		Avg	50.8			1		Avg	55.1		1.2		Avg	(NA)			(NA)		Avg	34.3			2.5	
8/14/98	7:28:23	3:02	F	Fender Point	80 20 26 W	19.7	Min	26.7	8781	80.3	0	0.22	Min	26.7	10931	0	0.25	Min	(NA)	0	0.0	(NA)	(NA)	Min	28.1	332	3.0	0.0	-1.80
							Max	78.4			5.6		Max	78.4		5.6		Max	(NA)			(NA)		Max	44.0			4.5	
					25 28 9 N		Avg	36.6			4.1		Avg	49.6		3.8		Avg	33.1			3.5		Avg	35.3			3.1	
8/14/98	11:12:14	2:59	F	Fender Point	80 20 26 W	39.1	Min	26.4	6578	60.9	0	0.72	Min	26.4	10795	0	-0.31	Min	27.5	564	5.2	0	0.96	Min	26.9	1242	11.5	0.0	0.84
							Max	51.5			9.2		Max	75.1		9.2		Max	40.6			7.6		Max	50.9			7.6	
							Avg	47.3			2.4		Avg	52.1		2.6		Avg	41.6			2.8		Avg	41.1			2.8	
FENDER POINT			F			33.2	Min	26.4	21777	66.8	0	-1.12	Min	26.4	32620	0	-0.82	Min	27.3	4469	13.7	0	1.10	Min	26.9	5479	16.8	0.0	-0.73
							Max	78.4			9.2		Max	78.4		9.2		Max	63.0			7.6		Max	63.0			7.6	
					25 24 12 N		Avg	47.5			8.3		Avg	47.8		7.6		Avg	46.7			7.3		Avg	46.7			7.3	
8/11/98	21:23:31	2:51	H	Mangrove Key	80 19 4 W	16.9	Min	44.4	8563	83.1	0	0.03	Min	44.4	10299	0	-0.05	Min	46.6	13	1.4	6.7	(NA)	Min	46.6	13	1.4	0.0	(NA)
							Max	51.7			14.8		Max	53.6		14.8		Max	46.6			7.4		Max	46.6			7.4	
					25 24 17 N		Avg	45.1			2.8		Avg	44.9		2.8		Avg	27.9			0.4		Avg	42.9			1.4	
8/15/98	7:57:41	3:45	H	Mangrove Key	80 18 54 W	42.6	Min	21.1	6373	57.4	0	2.30	Min	21.1	11100	0	1.84	Min	21.7	356	3.2	0	0.02	Min	21.1	854	7.7	0.0	1.97
							Max	68.4			10.3		Max	68.4		10.3		Max	37.1			2		Max	61.0			4.7	
							Avg	45.1			2.8		Avg	44.9		2.8		Avg	27.9			0.4		Avg	42.9			1.4	
MANGROVE KEY			H			42.6	Min	21.1	6373	57.4	0	2.30	Min	21.1	11100	0	1.84	Min	21.7	356	3.2	0	0.02	Min	21.1	854	7.7	0.0	1.97
							Max	68.4			10.3		Max	68.4		10.3		Max	37.1			2		Max	61.0			4.7	
					25 22 3 N		Avg	49.2			6.2		Avg	49.2		6.1		Avg	(NA)			(NA)		Avg	48.6			7.0	
8/11/98	11:00:55	4:40	E	Pacific Reef	80 8 54 W	19.5	Min	35.9	13550	80.5	0	1.47	Min	35.9	16828	0	1.51	Min	(NA)	(NA)	(NA)	(NA)	(NA)	Min	46.7	82	0.5	0.0	-0.14
							Max	57.7			10.1		Max	57.7		10.3		Max	(NA)			(NA)		Max	49.5			9.6	
					25 22 3 N		Avg	53.9			7.9		Avg	53.8		7.8		Avg	(NA)			(NA)		Avg	(NA)			(NA)	
8/16/98	9:14:34	3:00	E	Pacific Reef	80 8 54 W	27.9	Min	47.1	7796	72.1	0	0.15	Min	47.1	10806	0	0.16	Min	(NA)	(NA)	(NA)	(NA)	(NA)	Min	(NA)	0	0	(NA)	(NA)
							Max	61.3			11.6		Max	61.3		11.6		Max	(NA)			(NA)		Max	(NA)			(NA)	
							Avg	50.6			6.5		Avg	50.6		6.4		Avg	(NA)			(NA)		Avg	48.6			7.0	
PACIFIC REEF			E			22.8	Min	35.9	21346	77.2	0	1.72	Min	35.9	27634	0	1.74	Min	(NA)	(NA)	(NA)	(NA)	(NA)	Min	46.7	82	0.3	0.0	-0.14
							Max	61.3			11.6		Max	61.3		11.6		Max	(NA)			(NA)		Max	49.5			9.6	
					25 23 27 N		Avg	49.5			4.5		Avg	49.7		4.6		Avg	44.3			4.4		Avg	45.6			4.3	
8/11/98	8:01:47	2:59	D	Rubicon Key	80 13 58 W	34.5	Min	31.3	7039	65.5	1.3	0.26	Min	31.3	10748	1.3	-0.31	Min	31.3	2793	26.0	1.6	-1.93	Min	31.3	2882	26.8	1.6	-2.17
							Max	67.8			8.1		Max	67.8		8.1		Max	50.9			7.6		Max	58.6			7.6	
					25 23 31 N		Avg	51.3			8		Avg	52.0		8		Avg	46.7			6.3		Avg	48.7			7.3	
8/14/98	12:46:54	2:51	D	Rubicon Key	80 14 1 W	13.0	Min	34.6	8968	87.0	1.6	1.64	Min	34.6	10304	1.6	1.67	Min	34.6	257	2.5	4	0.98	Min	34.6	579	5.6	4.0	1.49
							Max	60.8			13.2		Max	68.0		13.2		Max	52.4			9.8		Max	54.1			12.1	
							Avg	50.6			6.5		Avg	51.0		6.3		Avg	44.6			4.6		Avg	46.3			4.8	
RUBICON KEY			D			24.0	Min	31.3	16007	76.0	1.3	1.42	Min	31.3	21052	1.3	1.32	Min	31.3	3050	14.5	1.6	-1.37	Min	31.3	3461	16.4	1.6	0.03
							Max	67.8			13.2		Max	68.0		13.2		Max	52.4			9.8		Max	58.6			12.1	
					25 35 28 N		Avg	56.5			4.2		Avg	58.6		4		Avg	54.4			4.2		Avg	56.5			4.2	
8/13/98	10:49:46	2:42	L	Soldier Key	80 9 39 W	82.1	Min	30.9	1753	17.9	1.6	1.85	Min	29.6	9768	1.3	-0.80	Min	31.8	510	5.2	1.6	3.45	Min	31.8	548	5.6	1.6	2.07
							Max	66.3			6.7		Max	77.7		7.2		Max	61.9			6.7		Max	64.4			6.7	
					25 35 28 N		Avg	60.7			5.6		Avg	60.2		5.7		Avg	58.1			5.5		Avg	62.3			6.0	
8/16/98	9:41:48	3:01	L	Soldier Key	80 9 39 W	73.0	Min	47.9	2941	27.0	2.5	1.57	Min	45.9	10891	2.5	0.56	Min	57.4	228	2.1	2.7	0.12	Min	57.4	1263	11.6	2.7	0.75
							Max	64.1			9.8		Max	71.1		10.1		Max	58.7			8.5		Max	64.1			9.8	
							Avg	58.7			4.8		Avg	59.2		4.5		Avg	55.2			4.4		Avg	60.2			5.1	
SOLDIER KEY			L			77.3	Min	30.9	4694	22.7	1.6	3.48	Min	29.6	20659	1.3	1.65	Min	31.8	738	3.6	1.6	4.17	Min	31.8	1811	8.8	1.6	3.52
							Max	66.3			9.8		Max	77.7		10.1		Max	61.9			8.5		Max	64.4			9.8	

Notes:

1. Data measured during the nighttime (Black Point and Mangrove Key) were not included in the overall average.
2. With the exception of Buchanan Key, (see Section 6.3.2), data were not filtered for wind speed, i.e., data were included regardless of wind speed.
3. (*) designates no meteorological data available. Field observer noted wind speeds less than 5 mph.

Table 4. Summary of Measured Ambient Sound Level Data (cont.)

Date	Start Time	Duration (Hr:Min)	Site ID	Site Name	Lat. / Long.	%TAAC	Traditional						Existing					Natural						Natural plus Visitor Self-Noise (N+VSN)					
								L_{Aeq} (dB)	DUR (s)	%T (%)	W/S (mph)	W/E (dB/mph)		L_{Aeq} (dB)	DUR (s)	W/S (mph)	W/E (dB/mph)		L_{Aeq} (dB)	DUR (s)	%T (%)	W/S (mph)	W/E (dB/mph)		L_{Aeq} (dB)	DUR (s)	%T (%)	W/S (mph)	W/E (dB/mph)
8/12/98	9:33:52	2:59	J	Stiltsville	25 37 18 N 80 8 54 W	58.9	Avg	53.4	4440	41.1	4.9	0.86	Avg	54.4	10790	4.8	0.98	Avg	(NA)	0	0	(NA)	(NA)	Avg	(NA)	0	0	(NA)	(NA)
							Min	39.1			0		Min	39.1		0		Min	(NA)			(NA)		Min	(NA)			(NA)	
							Max	69.3			8.7		Max	71.5		8.7		Max	(NA)			(NA)		Max	(NA)			(NA)	
8/16/98	14:14:47	2:57	J	Stiltsville	25 37 17 N 80 8 57 W	39.1	Avg	57.2	6482	60.9	10.2	0.22	Avg	57.4	10648	10.2	0.25	Avg	(NA)	0	0	(NA)	(NA)	Avg	(NA)	0	0	(NA)	(NA)
							Min	51.9			0		Min	45.6		0		Min	(NA)			(NA)		Min	(NA)			(NA)	
							Max	67.6			16.1		Max	67.6		16.1		Max	(NA)			(NA)		Max	(NA)			(NA)	
8/17/98	9:03:41	2:58	J	Stiltsville	25 37 45 N 80 12 6 W	44.7	Avg	54.1	5902	55.3	10.2	0.37	Avg	55.5	10681	10.3	0.55	Avg	(NA)	0	0	(NA)	(NA)	Avg	53.2	82	0.8	11.2	1.14
							Min	48.6			0		Min	48.6		0		Min	(NA)			(NA)		Min	50.1			0.0	
							Max	64.1			15		Max	72.6		15.2		Max	(NA)			(NA)		Max	55.1			13.9	
STILTSVILLE			J			47.0	Avg	54.9	16229	53.0	8.5	0.91	Avg	55.7	30634	7.1	0.90	Avg	(NA)	0	0.0	(NA)	(NA)	Avg	53.2	82	0.3	11.2	1.14
							Min	39.1			0		Min	39.1		0		Min	(NA)			(NA)		Min	50.1			0.0	
							Max	69.3			16.1		Max	72.6		16.1		Max	(NA)			(NA)		Max	55.1			13.9	
8/11/98	11:37:51	3:00	G	Visitors Center	25 27 52 N 80 20 5 W	43.7	Avg	59.0	6094	56.3	3.8	-1.43	Avg	60.8	10830	3.8	-0.39	Avg	(NA)	0	0.0	(NA)	(NA)	Avg	59.5	4598	42.5	3.8	-1.75
							Min	39.6			0		Min	39.3		0		Min	(NA)			(NA)		Min	39.6			0.0	
							Max	73.4			8.5		Max	84.0		9.2		Max	(NA)			(NA)		Max	73.4			8.5	
8/16/98	14:57:25	3:04	G	Visitors Center	25 27 52 N 80 20 5 W	27.2	Avg	48.7	8041	72.8	5.1	0.05	Avg	49.9	11052	5.1	0.10	Avg	43.1	114	1.0	4.6	-0.08	Avg	44.5	1123	10.2	5.3	0.04
							Min	39.7			0		Min	39.7		0		Min	42.7			2.5		Min	40.8			2.5	
							Max	61.8			9.6		Max	65.4		10.5		Max	44.0			7.8		Max	51.5			9.6	
VISITOR CENTER			G			35.4	Avg	57.4	14135	64.6	4.2	-1.63	Avg	59.5	21882	4.2	-1.31	Avg	43.1	114	0.5	4.6	-0.08	Avg	59.1	5721	26.1	3.9	-2.37
							Min	39.6			0		Min	39.3		0		Min	42.7			2.5		Min	39.6			0.0	
							Max	73.4			9.6		Max	84.0		10.5		Max	44.0			7.8		Max	73.4			9.6	
EVERGLADES NATIONAL PARK																													
8/10/98	15:21:52	3:00	B	Anhinga Trail	25 23 1 N 80 36 22 W	51.1	Avg	40.8	5284	48.9	1.6	0.40	Avg	41.5	10812	1.6	0.24	Avg	40.7	3913	36.2	1.8	0.21	Avg	40.7	4815	44.5	1.7	0.45
							Min	24.6			0		Min	24.6		0		Min	24.6			0		Min	24.6			0.0	
							Max	60.9			7.8		Max	60.9		7.8		Max	60.9			7.8		Max	60.9			7.8	
8/12/98	7:57:08	2:59	B	Anhinga Trail	25 23 1 N 80 36 22 W	46.1	Avg	58.8	5033	53.9	2	0.37	Avg	56.4	9332	1.9	0.09	Avg	65.6	620	6.6	2	0.69	Avg	63.3	1037	11.1	1.8	0.71
							Min	26.9			0		Min	26.9		0		Min	27.8			0		Min	27.8			0.0	
							Max	77.5			6.5		Max	77.5		6.5		Max	76.6			5.6		Max	76.6			5.6	
8/15/98	7:32:55	2:34	B	Anhinga Trail	25 23 1 N 80 36 22 W	54.7	Avg	52.0	4191	45.3	2	-0.27	Avg	51.2	9248	2.1	-0.10	Avg	56.2	1513	16.4	2.1	-0.48	Avg	53.7	2703	29.2	2.0	-0.37
							Min	33.1			0		Min	33.1		0		Min	33.1			0		Min	33.1			0.0	
							Max	77.4			5.8		Max	77.4		5.8		Max	77.4			5.8		Max	77.4			5.8	
ANHINGA			B			50.6	Avg	55.4	14508	49.4	1.8	0.38	Avg	53.0	29392	1.8	0.39	Avg	56.7	6046	20.6	1.9	0.30	Avg	55.6	8555	29.1	1.8	0.42
							Min	24.6			0		Min	24.6		0		Min	24.6			0		Min	24.6			0.0	
							Max	77.5			7.8		Max	77.5		7.8		Max	77.4			7.8		Max	77.4			7.8	
8/19/98	10:49:40	4:55	Y	Buchanan Key	24 54 58 N 80 46 29 W	6.0	Avg	45.8	16710	94.0	14.6	0.32	Avg	45.7	17769	14.6	0.31	Avg	44.6	6077	34.2	14.7	0.93	Avg	45.3	6216	35.0	14.7	0.76
							Min	37.9			9.2		Min	37.9		9.2		Min	33.6			9.2		Min	33.6			0.0	
							Max	63.5			19.9		Max	63.5		19.9		Max	53.6			19.5		Max	58.7			19.5	
BUCHANAN KEY			Y			6.0	Avg	45.8	16710	94.0	14.6	0.32	Avg	45.7	17769	14.6	0.31	Avg	44.6	6077	34.2	14.7	0.93	Avg	45.3	6216	35.0	14.7	0.76
							Min	37.9			9.2		Min	37.9		9.2		Min	33.6			9.2		Min	33.6			0.0	
							Max	63.5			19.9		Max	63.5		19.9		Max	53.6			19.5		Max	58.7			19.5	
8/10/98	8:52:42	4:11	O	Chekika	25 36 45 N 80 35 4 W	63.6	Avg	41.3	5496	36.4	3.7	0.77	Avg	42.3	15093	3.6	0.59	Avg	40.6	5034	33.4	3.8	0.81	Avg	40.8	5311	35.2	3.7	0.75
							Min	30.9			0		Min	30.9		0		Min	30.9			0		Min	30.9			0.0	
							Max	62.2			10.3		Max	63.6		10.3		Max	62.2			10.3		Max	62.2			10.3	
8/17/98	16:20:42	2:01	O	Chekika	25 36 45 N 80 35 4 W	68.4	Avg	40.2	2292	31.6	5.6	1.20	Avg	49.0	7262	5	0.48	Avg	40.0	1798	24.8	5.4	1.24	Avg	40.0	1798	24.8	5.4	1.24
							Min	31.3			1.6		Min	31.3		1.6		Min	32.0			1.6		Min	32.0			1.6	
							Max	46.4			15.7		Max	73.3		15.7		Max	45.9			15.7		Max	45.9			15.7	
CHEKIKA			O			65.2	Avg	41.0	7788	34.8	4.3	0.92	Avg	45.7	22355	4.1	0.72	Avg	40.4	6832	30.6	4.2	0.97	Avg	40.6	7109	31.8	4.1	0.91
							Min	30.9			0		Min	30.9		0		Min	30.9			0		Min	30.9			0.0	
							Max	62.2			15.7		Max	73.3		15.7		Max	62.2			15.7		Max	62.2			15.7	

Notes:

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3. (*) designates no meteorological data available. Field observer noted wind speeds less than 5 mph.

Table 4. Summary of Measured Ambient Sound Level Data (cont.)

Date	Start Time	Duration (Hr:Min)	Site ID	Site Name	Lat. / Long.	%TA$_{AC}$	Traditional						Existing					Natural						Natural plus Visitor Self-Noise (N+VSN)					
								L_{Aeq} (dB)	DUR (s)	%T (%)	W/S (mph)	W/E (dB/mph)		L_{Aeq} (dB)	DUR (s)	W/S (mph)	W/E (dB/mph)		L_{Aeq} (dB)	DUR (s)	%T (%)	W/S (mph)	W/E (dB/mph)		L_{Aeq} (dB)	DUR (s)	%T (%)	W/S (mph)	W/E (dB/mph)
					25 17 16 N		Avg	54.9			5.2		Avg	54.5		5.2		Avg	59.5			6		Avg	59.5			6.0	
8/13/98	12:30:52	2:54	M	Eastern Panhandle	80 26 30 W	18.3	Min	32.1	8546	81.7	0	-0.41	Min	32.1	10461	0	-0.34	Min	32.1	1042	10.0	3.6	-2.81	Min	32.1	1042	10.0	0.0	-2.81
							Max	76.6			11.4		Max	76.6		11.4		Max	75.7			10.3		Max	75.7			10.3	
							Avg	54.9			5.2		Avg	54.5		5.2		Avg	59.5			6.0		Avg	59.5			6.0	
EASTERN PANHANDLE			M			18.3	Min	32.1	8546	81.7	0	-0.41	Min	32.1	10461	0	-0.34	Min	32.1	1042	10.0	3.6	-2.81	Min	32.1	1042	10.0	0.0	-2.81
							Max	76.6			11.4		Max	76.6		11.4		Max	75.7			10.3		Max	75.7			10.3	
					25 29 52 N		Avg	31.2			5.4		Avg	48.7		5.3		Avg	31.2			5.5		Avg	31.2			5.4	
8/18/98	9:41:18	5:11	V	Eastern Sparrow	80 39 45 W	53.8	Min	24.1	8646	46.2	0	1.49	Min	24.1	18699	0	1.27	Min	22.0	8603	46.0	0	1.50	Min	22.0	8646	46.2	0.0	1.49
							Max	45.8			12.1		Max	78.2		18.1		Max	45.8			12.1		Max	45.8			12.1	
							Avg	31.2			5.4		Avg	48.7		5.3		Avg	31.2			5.5		Avg	31.2			5.4	
EASTERN SPARROW			V			53.8	Min	24.1	8646	46.2	0	1.49	Min	24.1	18699	0	1.27	Min	22.0	8603	46.0	0	1.50	Min	22.0	8646	46.2	0.0	1.49
							Max	45.8			12.1		Max	78.2		18.1		Max	45.8			12.1		Max	45.8			12.1	
					25 8 19 N		Avg	48.3			1.2		Avg	48.8		1.3		Avg	48.1			1.4		Avg	48.0			1.5	
8/14/98	8:44:40	5:54	Q	Eco Pond	80 56 16 W	32.2	Min	41.4	14417	67.8	0	-0.69	Min	41.4	21262	0	-0.56	Min	37.7	5372	25.3	0	-0.25	Min	37.7	6342	29.8	0.0	-0.39
							Max	58.4			7.6		Max	59.0		7.6		Max	54.4			7.2		Max	54.4			7.6	
							Avg	48.3			1.2		Avg	48.8		1.3		Avg	48.1			1.4		Avg	48.0			1.5	
ECO POND			Q			32.2	Min	41.4	14417	67.8	0	-0.69	Min	41.4	21262	0	-0.56	Min	37.7	5372	25.3	0	-0.25	Min	37.7	6342	29.8	0.0	-0.39
							Max	58.4			7.6		Max	59.0		7.6		Max	54.4			7.2		Max	54.4			7.6	
					25 22 55 N		Avg	35.7			1.3		Avg	40.4		1.2		Avg	35.1			1.1		Avg	35.1			1.1	
8/15/98	11:55:29	3:09	R	Hidden Lake	80 37 6 W	61.1	Min	27.2	4206	38.9	0	0.39	Min	27.2	10814	0	0.08	Min	27.9	2808	26.0	0	0.16	Min	27.9	2808	26.0	0.0	0.16
							Max	51.0			5.6		Max	63.5		5.6		Max	51.0			5.6		Max	51.0			5.6	
					25 22 55 N		Avg	36.1			1.4		Avg	39.4		1.3		Avg	37.2			1.4		Avg	37.2			1.4	
8/17/98	16:44:41	1:48	R	Hidden Lake	80 37 6 W	48.8	Min	24.6	3349	51.2	0	1.06	Min	24.6	6541	0	0.56	Min	24.6	3212	49.1	0	1.06	Min	27.2	3212	49.1	0.0	1.06
							Max	49.6			6.5		Max	57.5		6.9		Max	49.6			6.5		Max	49.6			6.5	
							Avg	36.0			1.3		Avg	39.8		1.2		Avg	36.4			1.3		Avg	36.2			1.3	
HIDDEN LAKE			R			56.5	Min	24.6	7555	43.5	0	0.72	Min	24.6	17355	0	0.30	Min	24.6	6020	34.7	0	0.69	Min	27.2	6020	34.7	0.0	0.69
							Max	51.0			6.5		Max	63.5		6.9		Max	51.0			6.5		Max	51.0			6.5	
					25 11 45 N		Avg	47.5			10.5		Avg	47.8		10.3		Avg	(NA)			(NA)		Avg	(NA)			(NA)	
8/18/98	8:32:20	3:05	U	Little Madeira Bay	80 37 42 W	17.0	Min	31.2	9285	83.0	0	0.52	Min	35.1	11182	0	0.37	Min	(NA)	0	0.0	(NA)	(NA)	Min	(NA)	0	0.0	(NA)	(NA)
							Max	55.7			15.2		Max	56.3		15.2		Max	(NA)			(NA)		Max	(NA)			(NA)	
					25 10 53 N		Avg	44.4			12.6		Avg	45.8		12.6		Avg	43.9			12.4		Avg	43.9			12.4	
8/20/98	10:48:26	1:26	U	Little Madeira Bay	80 38 21 N	18.5	Min	39.8	4244	81.5	8.5	0.64	Min	39.8	5209	8.5	0.31	Min	39.8	1527	29.3	8.5	0.63	Min	39.8	1527	29.3	0.0	0.63
							Max	49.3			16.8		Max	59.2		16.8		Max	47.6			15.4		Max	47.6			15.4	
							Avg	46.7			11.2		Avg	47.3		11.0		Avg	43.9			12.4		Avg	43.9			12.4	
LITTLE MADEIRA BAY			U			17.5	Min	31.2	13529	82.5	0	-0.15	Min	35.1	16391	0	-0.19	Min	39.8	1527	9.3	8.5	0.63	Min	39.8	1527	9.3	0.0	0.63
							Max	55.7			16.8		Max	59.2		16.8		Max	47.6			15.4		Max	47.6			15.4	

Notes:

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Date	Start Time	Duration (Hr:Min)	Site ID	Site Name	Lat. / Long.	%TA_{cc}	Traditional						Existing					Natural						Natural plus Visitor Self-Noise (N+VSN)					
								L_{Aeq} (dB)	DUR (s)	%T (%)	W/S (mph)	W/E (dB/mph)		L_{Aeq} (dB)	DUR (s)	W/S (mph)	W/E (dB/mph)		L_{Aeq} (dB)	DUR (s)	%T (%)	W/S (mph)	W/E (dB/mph)		L_{Aeq} (dB)	DUR (s)	%T (%)	W/S (mph)	W/E (dB/mph)
					25 9 6 N		Avg	39.8			4.9		Avg	42.1		4.8		Avg	40.1			4.9		Avg	40.1			4.9	
8/18/98	14:34:24	2:54	X	North Nest Key	80 30 41 W	24.5	Min	21.3	7945	75.5	0	0.74	Min	21.3	10517	0	0.17	Min	21.3	7415	70.5	0	0.72	Min	21.3	7415	70.5	0	0.72
							Max	59.7			10.3		Max	59.7		10.3		Max	59.7			10.3		Max	59.7			10.3	
							Avg	39.8			4.9		Avg	42.1		4.8		Avg	40.1			4.9		Avg	40.1			4.9	
NORTH NEST KEY			X			24.5	Min	21.3	7945	75.5	0	0.74	Min	21.3	10517	0	0.17	Min	21.3	7415	70.5	0	0.72	Min	21.3	7415	70.5	0.0	0.72
							Max	59.7			10.3		Max	59.7		10.3		Max	59.7			10.3		Max	59.7			10.3	
					25 42 31 N		Avg	45.4			7.7		Avg	46.1		7.8		Avg	45.5			7.8		Avg	45.6			7.8	
8/20/98	8:07:21	2:58	AA	Pavilion Key	81 21 3 W	10.7	Min	31.6	9587	89.3	3.8	1.71	Min	31.6	10730	3.8	1.67	Min	31.6	5267	49.1	4	1.74	Min	31.6	5328	49.7	4	1.80
							Max	54.8			13.4		Max	63.7		14.3		Max	54.8			13		Max	54.8			13	
							Avg	45.4			7.7		Avg	46.1		7.8		Avg	45.5			7.8		Avg	45.6			7.8	
PAVILION KEY			AA			10.7	Min	31.6	9587	89.3	3.8	1.71	Min	31.6	10730	3.8	1.67	Min	31.6	5267	49.1	4	1.74	Min	31.6	5328	49.7	4.0	1.80
							Max	54.8			13.4		Max	63.7		14.3		Max	54.8			13		Max	54.8			13.0	
					25 25 22 N		Avg	41.6			*		Avg	44.1		*		Avg	41.7			*		Avg	41.3			*	
8/12/98	15:18:02	1:46	K	Pinelands	80 40 47 W	24.0	Min	27.9	4857	76.0	*	*	Min	27.9	6390	*	*	Min	27.9	1567	24.5	*	*	Min	27.9	1871	29.3	*	*
							Max	54.6			*		Max	60.5		*		Max	54.6			*		Max	54.6			*	
					25 25 22 N		Avg	45.2			0.4		Avg	45.0		0.5		Avg	45.0			0.4		Avg	44.9			0.4	
8/13/98	7:18:59	3:01	K	Pinelands	80 40 47 W	28.8	Min	31.6	7760	71.2	0	-1.92	Min	31.6	10902	0	-1.73	Min	31.6	5039	46.2	0	-2.42	Min	31.6	5171	47.4	0.0	-2.41
							Max	52.0			3.8		Max	53.6		3.8		Max	49.9			3.4		Max	49.9			3.4	
					25 25 22 N		Avg	49.8			1.5		Avg	50.1		1.4		Avg	50.0			1.4		Avg	49.9			1.5	
8/19/98	8:48:18	2:52	K	Pinelands	80 40 47 W	31.7	Min	34.1	7261	68.3	0	-0.63	Min	34.1	10630	0	-0.64	Min	34.1	4463	42.0	0	-0.71	Min	34.1	5069	47.7	0.0	-0.64
							Max	53.8			6.9		Max	60.5		6.9		Max	53.8			6.9		Max	53.8			6.9	
							Avg	47.1			0.9		Avg	47.6		0.9		Avg	47.5			0.9		Avg	47.5			0.9	
PINELANDS			K			28.8	Min	27.9	19878	71.2	0	0.18	Min	27.9	27922	0	0.15	Min	27.9	11069	39.6	0	-0.03	Min	27.9	12111	43.4	0.0	0.08
							Max	54.6			6.9		Max	60.5		6.9		Max	54.6			6.9		Max	54.6			6.9	
					25 39 23 N		Avg	42.1			1.3		Avg	44.2		1.1		Avg	43.2			1		Avg	41.9			1.3	
8/13/98	9:26:15	3:03	N	Shark Valley	80 45 59 W	31.3	Min	34.6	7581	68.7	0	-0.22	Min	34.6	11042	0	-0.30	Min	35.4	1824	16.5	0	-0.11	Min	34.6	5242	47.5	0.0	-0.38
							Max	57.8			6.3		Max	60.7		6.3		Max	57.8			4		Max	57.8			6.3	
					25 39 23 N		Avg	49.1			2.6		Avg	49.2		2.7		Avg	46.3			2.5		Avg	46.5			2.6	
8/16/98	8:05:23	2:58	N	Shark Valley	80 45 59 W	16.4	Min	40.3	8934	83.6	0	0.58	Min	40.3	10688	0	0.64	Min	42.3	4783	44.8	0	0.18	Min	41.9	5775	54.0	0.0	0.32
							Max	62.4			6.3		Max	62.4		6.3		Max	55.2			6.3		Max	55.2			6.3	
							Avg	45.7			1.7		Avg	46.3		1.5		Avg	45.1			1.8		Avg	43.9			1.7	
SHARK VALLEY			N			24.0	Min	34.6	16515	76.0	0	1.46	Min	34.6	21730	0	1.33	Min	35.4	6607	30.4	0	1.28	Min	34.6	11017	50.7	0.0	1.09
							Max	62.4			6.3		Max	62.4		6.3		Max	57.8			6.3		Max	57.8			6.3	
					25 14 48 N		Avg	42.0			10.9		Avg	44.0		10.8		Avg	38.0			8.7		Avg	38.0			8.7	
8/17/98	11:12:04	2:56	T	Whitewater Bay	80 57 51 W	25.6	Min	34.7	7910	74.4	6.3	0.77	Min	34.7	10637	6.3	0.77	Min	38.0	15	0.1	8.3	(NA)	Min	38.0	15	0.1	8.3	(NA)
							Max	50.4			15.9		Max	63.6		16.6		Max	38.0			9.2		Max	38.0			9.2	
							Avg	42.0			10.9		Avg	44.0		10.8		Avg	38.0			8.7		Avg	38.0			8.7	
WHITEWATER BAY			T			25.6	Min	34.7	7910	74.4	6.3	0.77	Min	34.7	10637	6.3	0.77	Min	38.0	15	0.1	8.3	(NA)	Min	38.0	15	0.1	8.3	(NA)
							Max	50.4			15.9		Max	63.6		16.6		Max	38.0			9.2		Max	38.0			9.2	
CROCODILE LAKE NATIONAL WILDLIFE PRESERVE																													
					25 14 29 N		Avg	39.9			5.5		Avg	44.4		5.6		Avg	36.4			5.5		Avg	36.0			5.6	
8/19/98	12:26:15	1:48	AD	Barnes Sound	80 20 3 W	30.5	Min	27.5	4500	69.5	1.3	0.49	Min	27.5	6472	1.3	0.42	Min	27.6	266	4.1	2.7	0.80	Min	27.6	427	6.6	2.5	0.52
							Max	60.4			11.4		Max	61.3		13.4		Max	41.3			9.6		Max	41.3			9.6	
							Avg	39.9			5.5		Avg	44.4		5.6		Avg	36.4			5.5		Avg	36.0			5.6	
BARNES SOUND			AD			30.5	Min	27.5	4500	69.5	1.3	0.49	Min	27.5	6472	1.3	0.42	Min	27.6	266	4.1	2.7	0.80	Min	27.6	427	6.6	2.5	0.52
							Max	60.4			11.4		Max	61.3		13.4		Max	41.3			9.6		Max	41.3			9.6	
					25 15 56 N		Avg	41.3			4.5		Avg	44.1		4.4		Avg	39.7			4.3		Avg	41.7			4.6	
8/18/98	10:43:46	2:55	W	Hardwood Hammock	80 18 39 W	20.8	Min	22.4	8355	79.2	0	0.62	Min	22.4	10551	0	0.54	Min	24.8	590	5.6	0	1.36	Min	24.8	1542	14.6	0	1.23
							Max	57.8			9.6		Max	65.4		9.8		Max	53.6			9.2		Max	53.6			9.2	
							Avg	41.3			4.5		Avg	44.1		4.4		Avg	39.7			4.3		Avg	41.7			4.6	
HARDWOOD HAMMOCK			W			20.8	Min	22.4	8355	79.2	0	0.62	Min	22.4	10551	0	0.54	Min	24.8	590	5.6	0	1.36	Min	24.8	1542	14.6	0.0	1.23
							Max	57.8			9.6		Max	65.4		9.8		Max	53.6			9.2		Max	53.6			9.2	

Notes:
1. Data measured during the nighttime (Black Point and Mangrove Key) were not included in the overall average.
2. With the exception of Buchanan Key, (see Section 6.3.2), data were not filtered for wind speed, i.e., data were included regardless of wind speed.
3. (*) designates no meteorological data available. Field observer noted wind speeds less than 5 mph.

Table 4. Summary of Measured Ambient Sound Level Data (cont.)

Date	Start Time	Duration (Hr:Min)	Site ID	Site Name	Lat. / Long.	$\%TA_{AC}$	Traditional						Existing					Natural						Natural plus Visitor Self-Noise (N+VSN)					
								L_{Aeq} (dB)	DUR (s)	%T (%)	W/S (mph)	W/E (dB/mph)		L_{Aeq} (dB)	DUR (s)	W/S (mph)	W/E (dB/mph)		L_{Aeq} (dB)	DUR (s)	%T (%)	W/S (mph)	W/E (dB/mph)		L_{Aeq} (dB)	DUR (s)	%T (%)	W/S (mph)	W/E (dB/mph)
8/18/98	8:03:34	1:30	AC	Mangrove Inlet	25 13 36 N	17.8	Avg	41.7	4441	82.2	4.5	-0.07	Avg	42.1	5404	4.4	-0.04	Avg	31.4	108	2.0	4.4	0.55	Avg	31.4	108	2.0	4.4	0.55
					80 20 1 W		Min	28.6			0.2		Min	28.4		0.2		Min	29.6			2.2		Min	29.6			0.0	
							Max	51.9			10.5		Max	51.9		10.5		Max	34.6			7.4		Max	34.6			7.4	
8/18/98	14:39:41	1:30	AC	Mangrove Inlet	25 13 36 N	15.4	Avg	39.6	4579	84.6	4.1	0.01	Avg	39.8	5410	4	-0.03	Avg	33.4	198	3.7	5.6	0.79	Avg	33.4	198	3.7	5.6	0.79
					80 20 1 W		Min	28.0			0		Min	28.0		0		Min	28.1			2		Min	28.1			0.0	
							Max	53.1			9.4		Max	53.1		9.4		Max	38.8			9.4		Max	38.8			9.4	
MANGROVE INLET			AC			16.6	Avg	40.8	9020	83.4	4.3	0.11	Avg	41.1	10814	4.2	0.11	Avg	32.8	306	2.8	5.2	0.75	Avg	32.8	306	2.8	5.2	0.75
							Min	28.6			0		Min	28.4		0		Min	28.1			2		Min	28.1			0.0	
							Max	53.1			10.5		Max	53.1		10.5		Max	38.8			9.4		Max	38.8			9.4	
BIG CYPRESS NATIONAL PRESERVE																													
8/16/98	12:52:40	2:48	S	Golightly	25 45 17 N	5.3	Avg	53.6	9531	94.7	2.2	-0.22	Avg	53.4	10063	2.1	-0.21	Avg	36.0	2044	20.3	2.3	-0.32	Avg	39.5	2689	26.7	2.2	-0.38
					80 55 35 W		Min	28.1			0		Min	28.1		0		Min	28.1			0		Min	28.1			0.0	
							Max	78.3			8.3		Max	78.3		8.3		Max	53.4			8.1		Max	54.6			8.1	
8/17/98	7:59:03	2:59	S	Golightly	25 45 17 N	21.0	Avg	43.0	8498	79.0	1.6	0.52	Avg	43.3	10762	1.6	0.64	Avg	42.7	6659	61.9	1.7	0.62	Avg	42.7	6659	61.9	1.7	0.62
					80 55 35 W		Min	30.3			0		Min	30.3		0		Min	30.3			0		Min	30.3			0.0	
							Max	55.1			7.2		Max	56.0		7.2		Max	55.1			7.2		Max	55.1			7.2	
GOLIGHTLY			S			13.4	Avg	49.3	18029	86.6	1.8	0.17	Avg	48.8	20825	1.7	0.24	Avg	42.3	8703	41.8	1.8	0.02	Avg	42.4	9348	44.9	1.8	0.05
							Min	28.1			0		Min	28.1		0		Min	28.1			0		Min	28.1			0.0	
							Max	78.3			8.3		Max	78.3		8.3		Max	55.1			8.1		Max	55.1			8.1	
8/20/98	8:43:50	2:37	AE	National Scenic Trail	25 51 47 N	59.8	Avg	43.5	3788	40.2	6.5	-0.85	Avg	58.4	9428	6.3	-0.38	Avg	44.6	541	5.7	6.9	-0.63	Avg	44.9	677	7.2	6.6	-1.07
					81 2 6 W		Min	30.4			2.9		Min	30.4		2.2		Min	30.4			3.6		Min	30.4			2.9	
							Max	58.6			12.1		Max	77.1		12.1		Max	55.6			12.1		Max	55.6			12.1	
NATIONAL SCENIC TRAIL			AE			59.8	Avg	43.5	3788	40.2	6.5	-0.85	Avg	58.4	9428	6.3	-0.38	Avg	44.6	541	5.7	6.9	-0.63	Avg	44.9	677	7.2	6.6	-1.07
							Min	30.4			2.9		Min	30.4		2.2		Min	30.4			3.6		Min	30.4			2.9	
							Max	58.6			12.1		Max	77.1		12.1		Max	55.6			12.1		Max	55.6			12.1	

Notes:
1. Data measured during the nighttime (Black Point and Mangrove Key) were not included in the overall average.
2. With the exception of Buchanan Key, (see Section 6.3.2), data were not filtered for wind speed, i.e., data were included regardless of wind speed.
3. (*) designates no meteorological data available. Field observer noted wind speeds less than 5 mph.

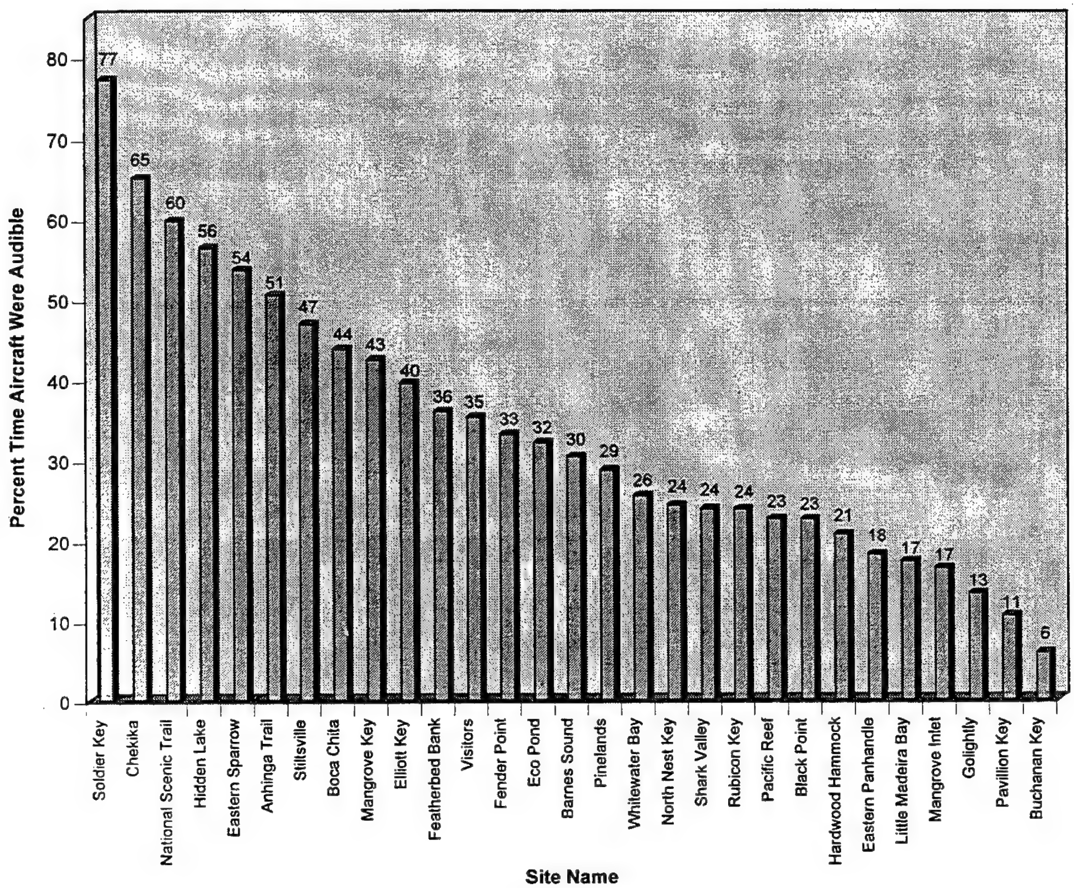


Figure 24. Ranking of Percent Measurement Time Aircraft were Audible at Each Site

effect at a particular site fell into one of three categories: (1) the wind effect was a positive value that was determined to be statistically significant. Generally, at these sites, the wind speed varied over a large range and human- and animal-generated sounds were not too intrusive (Category 1). Wind effect values designated as Category 1 were considered to be the most reliable numbers, as compared with those designated as either Category 2 or 3; (2) the wind effect was either not statistically significant or it was significant but potentially misleading due to the low range in wind speeds represented (Category 2 -- average wind speeds less than 5 mph); and (3) the wind effect was either not statistically significant or was significant but misleading due to masking effects from human and animal/insect generated sounds (Category 3).

The remainder of Section 6 discusses the data presented in Table 4. Specifically, Section 6.2 presents the rationale for using traditional ambient for the Homestead SEIS, while Sections 6.3 through 6.6 include a detailed discussion of the data.

6.2 Selection of Traditional Ambient Sound Level for Homestead SEIS

Sections 6.2 through 6.5 include a detailed discussion of the data presented in Table 4. The discussion contained in these sections focuses on the data measured for the traditional ambient. The research team spent a fairly substantial amount of time discussing with the FAA which definition of ambient should be the primary focus of its work for the Homestead SEIS. The FAA, in turn, addressed this question with the Air Force, NPS, and other Federal agencies involved in the SEIS.

The FAA advised the research team that its objective was to describe the affected environment as prescribed in regulations issued by the President's Council on Environmental Quality (CEQ) that implement the National Environmental Policy Act (NEPA). The CEQ regulations state in section

1502.15, "The environmental impact statement shall succinctly describe the environment of the area(s) to be affected or created by the alternatives under consideration. The descriptions shall be no longer than is necessary to understand the effects of the alternatives." Consistent with the CEQ regulations and its own NEPA guidance, the FAA wanted to describe the existing noise environment in the four conservation units in order to evaluate how that noise environment would potentially be affected by the proposed action and alternative actions being considered for the reuse of Homestead Air Base.

The existing noise environment includes all noise at a location-sounds of nature, visitors, mechanical noise (including equipment, cars, motor boats), and existing aircraft noise from Homestead and other airports. It was first thought that the measured existing ambient, which includes all of the above sounds, would be the appropriate choice for describing the affected noise environment. On second thought, however, it was determined that average annual aircraft noise could best be represented by computer modeling, rather than using the measured data. Aircraft information used in modeling comes from ARTS radar data and airport operations data-sources that are more complete and reliable than short-term field measurements in establishing a baseline for twelve-month average aircraft noise effects. In addition, computer modeling is the only way to evaluate future aircraft noise effects of different levels of airport use and alternative flight tracks for Homestead, since these do not presently exist and so cannot be measured. The modeling of existing aircraft noise facilitates comparisons with potential future conditions and alternatives.

For these reasons, the determination was made to describe the affected environment by using the results of the measured traditional ambient data for all sounds except aircraft and by adding computer-generated aircraft noise results to the traditional ambient. This report focuses on the measurement and mapping of the traditional ambient. The technical memorandum prepared by Landrum & Brown uses this traditional ambient measurement and mapping and adds the aircraft noise component through modeling.

Data for all four categories of ambient that were measured are presented in Table 4 for completeness and consistency with Reference 5. It is interesting to point out that, with the exception of two sites, Eastern Sparrow in ENP and Natural Scenic Trail in BCY, the traditional and existing ambient were within 5 dB (more typically within 2 dB) of one another, with the existing usually higher in level. Table 5 summarizes these differences.

With respect to the measured natural ambient, many of the sites (especially in BNP) were so developed that very little data were measured under a natural state due to the abundance of noise associated with man-made activity (mostly mechanical sounds). The low amount of time that natural ambient predominated results in little statistical confidence in the final natural ambient values and undermines the consideration of the natural ambient in this case as possibly a more appropriate descriptor than the traditional ambient of the existing affected noise environment. It is also important to point out, for those who may assume that natural ambient values are always the "quietest," that the natural ambient sound level was not always the lowest relative to the other ambient values. At some of the sites, the sound of nature at close range, in particular insect-related activity, was so loud that it effectively masked all other sounds that occurred at greater distances from the noise receiver (see Section 6.2.9 Soldier Key, and Section 6.3.11 Pinelands).

The possible use of the Natural plus Visitor Self-Noise (N+VSN) ambient to describe the existing affected environment would have presented other problems in addition to not accounting for all existing sounds. The park-visitor component of the ambient as envisioned by the NPS in the 1995 Report to Congress encompassed the sound of hiking boots on the trail and visitor pots and pans. This description of visitor self-generated noise was really oriented towards the western U.S. parks where hiking and camping are the primary visitor attraction and use for the park. The description is not a good fit for an aquatic park like BNP that is dominated almost entirely by somewhat random boat-related visitor activity and is probably only marginally more appropriate for ENP.

Table 5. Difference in Traditional and Existing Ambient Sound Levels

Measurement Site	Difference (dB)
Biscayne National Park (BNP)	
Black Point	2.8
Boca Chita	2.0
Elliott Key	-0.1
Featherbed Bank	0.1
Fender Point	4.8
Mangrove Key	-0.2
Pacific Reef	0.1
Rubicon Key	0.4
Soldier Key	0.5
Stiltsville	0.8
Visitor Center	2.1
Everglades National Park (ENP)	
Anhinga Trail	-2.4
Buchanan Key	-0.1
Chekika	4.7
Eastern Panhandle	-0.4
Eastern Sparrow	17.5
Eco Pond	0.5
Hidden Lake	3.8
Little Madeira Bay	0.5
North Nest Key	2.3
Pavilion Key	0.7
Pinelands	0.5
Shark Valley	0.6
Whitewater Bay	2.0
Crocodile Lake National Wildlife Refuge (CLK)	
Barnes Sound	4.5
Hardwood Hammock	2.8
Mangrove Inlet	0.3
Big Cypress National Preserve (BCY)	
Golightly Campground	-0.5
National Scenic Trail	14.9

For the reasons above, Sections 6.3 through 6.6 focus on the data presented for the traditional ambient sound level. Data for the other three categories of ambient are presented in the table: for completeness; for consistency with Reference 5; and also to facilitate possible alternative analyses.

6.3 Biscayne National Park

This section presents a discussion of the traditional ambient sound level data measured at the eleven BNP sites. The sites are presented in alphabetical order.

6.3.1 Black Point

Black Point was a water-based site where measurements were made on two separate occasions as follows: (1) Monday, August 10 from 08:03 to 10:30 (2 hours, 27 minutes); and (2) during a nighttime period on Wednesday, August 12 from 21:03 to 00:00 (2 hours, 57 minutes). The reason this site was identified by the NPS as a candidate site for nighttime measurements was that it is located adjacent to a bird sanctuary, and prior NPS research indicated birds to be especially noise-sensitive during the nighttime.

As can be seen from the summary data, the traditional ambient sound level was extremely consistent for the morning and nighttime measurements (51.8 versus 50.7 dB, with the slightly lower value occurring during the nighttime measurements on August 12). Although nighttime measurements were made at this site, for consistency with the analysis performed at other sites, nighttime data were not included in the final traditional ambient (i.e., with the exception of this site and one measurement segment at Mangrove Key, all the study data were measured during daytime hours). As such, the averaged traditional ambient at Black Point was 51.8 dB (the same value measured for the morning measurement period).

At Black Point a fairly wide range of wind speeds was observed (see Figure 25). In fact, a direct relationship between wind speed and wave-on-the-hull noise was observed at this site. Consequently,

the computed wind effect of 0.20 dB/mph was determined to be statistically significant (assuming a 95 percent confidence interval). In accordance with Section 6.1, the wind effect at this site was classified as Category 1.

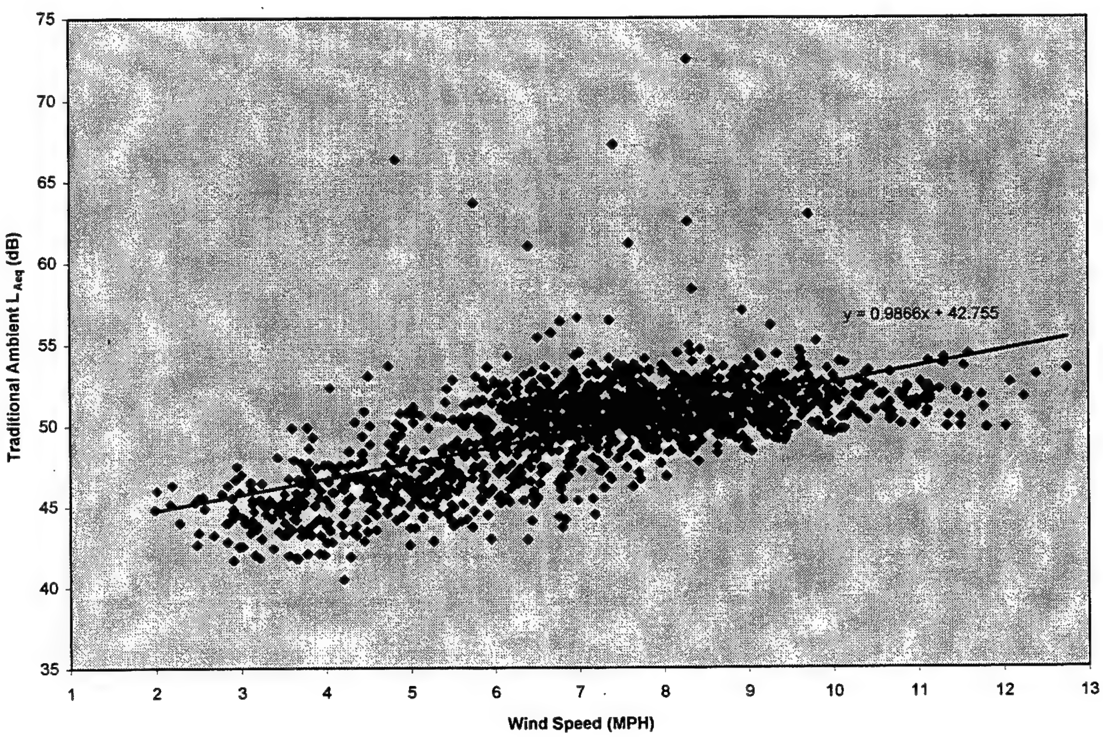


Figure 25. Traditional Ambient L_{Aeq} vs. Wind Speed: Black Point

6.3.2 Boca Chita

At Boca Chita, measurements were made on three separate occasions as follows: (1) Monday, August 10 from 12:13 to 14:59 (2 hours, 46 minutes); (2) Thursday, August 13 from 15:01 to 17:48 (2 hours, 47 minutes); and (3) Saturday, August 15 from 12:13 to 15:12 (2 hours 59 minutes). Weekday measurements were conducted so as to represent a substantial portion of the daylight hours, i.e., those

hours when park visitation was expected to be at its peak. In addition, day-to-day variation in visitor activity was of particular concern at Boca Chita. Consequently, a third measurement was conducted on the weekend when visitor volume due to boating activity was expected to increase. The specific time-of-day selected for weekend measurements was chosen so as to overlap with the time-of-day associated with one of the two weekday measurements. By doing so, a so-called "weekend offset" could be most easily quantified.

As can be seen from the summary data, the traditional ambient sound level was extremely consistent for the two weekday measurements (47.2 dB on August 10 versus 46.4 dB on August 13). However, an approximate 5 dB increase was measured on the weekend (52.0 dB). This increase can be directly attributed to the increased visitor volume associated with increased boating activity. In fact, the percent of time boats (or boat-related activity, e.g., boat radios) were audible increased from 29.0 percent (on August 10) and 24.2 percent (on August 13) during the week to 55.7 percent on the weekend. Data from the three time periods were averaged as discussed in Section 5.3; and the resultant traditional ambient at Boca Chita was 48.6 dB.

In terms of the wind effect, vegetation on Boca Chita was relatively sparse, with grass, sandy scrub, and a few palm trees scattered about. Further, the computed wind effect which was effectively zero was determined to be not statistically significant (assuming a 95 percent confidence interval). In accordance with Section 6.1, the wind effect at this site was classified as Category 1, even though zero wind effect was computed.

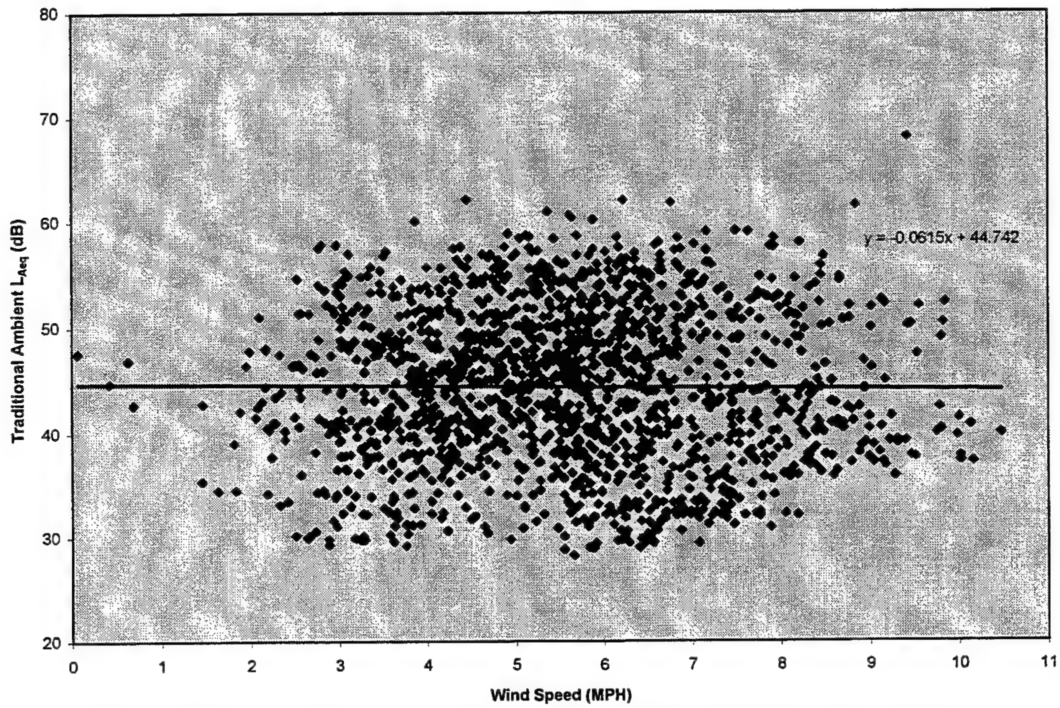


Figure 26. Traditional Ambient L_{Aeq} vs. Wind Speed: Boca Chita

6.3.3 Elliott Key

Like Boca Chita, the Elliott Key measurements were made on three separate occasions as follows: (1) Wednesday, August 12 from 09:35 to 12:37 (3 hours, 2 minutes); (2) Saturday, August 15 from 14:13 to 17:10 (2 hours, 57 minutes); and (3) Monday, August 17 from 13:27 to 16:26 (2 hours, 59 minutes). Weekday measurements were conducted in the morning and in the afternoon so as to represent a substantial portion of the daylight hours, i.e., those hours when park visitation was expected to be at its peak. In addition, day-to-day variation in visitor activity was of particular concern at Elliott Key. Consequently, a third measurement was conducted on the weekend when visitor volume due to boating activity was expected to increase. The specific time-of-day selected for weekend measurements was chosen so as to overlap with the time-of-day associated with one of the two weekday measurements. By doing so, a so-called "weekend offset" could be most easily quantified.

As can be seen from the summary data, the traditional ambient sound level was fairly consistent for the two weekday measurements (44.1 dB versus 47.2 dB, with the lower value occurring during the morning measurements on the August 12). However, an approximate 6 to 9 dB increase was measured on the weekend (53.8 dB). This increase can be directly attributed to the increased visitor volume associated with increased boating activity. In fact, the percent of time boats (or boat-related activity, e.g., boat radios) were audible increased from 4.6 percent (on August 12) and 1.9 percent (on August 15) during the week to 14.4 percent on the weekend. Data from the three time periods were averaged as discussed in Section 5.3; and the resultant traditional ambient at Elliott Key was 49.3 dB.

In terms of the wind effect, although vegetation on Elliott Key was quite dense in areas, the measured wind speed data did not encompass a wide range (see Figure 27). In fact, the average wind speed at Elliott Key was just 3.3 mph. Consequently, the computed wind effect was determined to be not statistically significant (assuming a 95 percent confidence interval). In accordance with Section 6.1, the wind effect at this site was classified as Category 2.

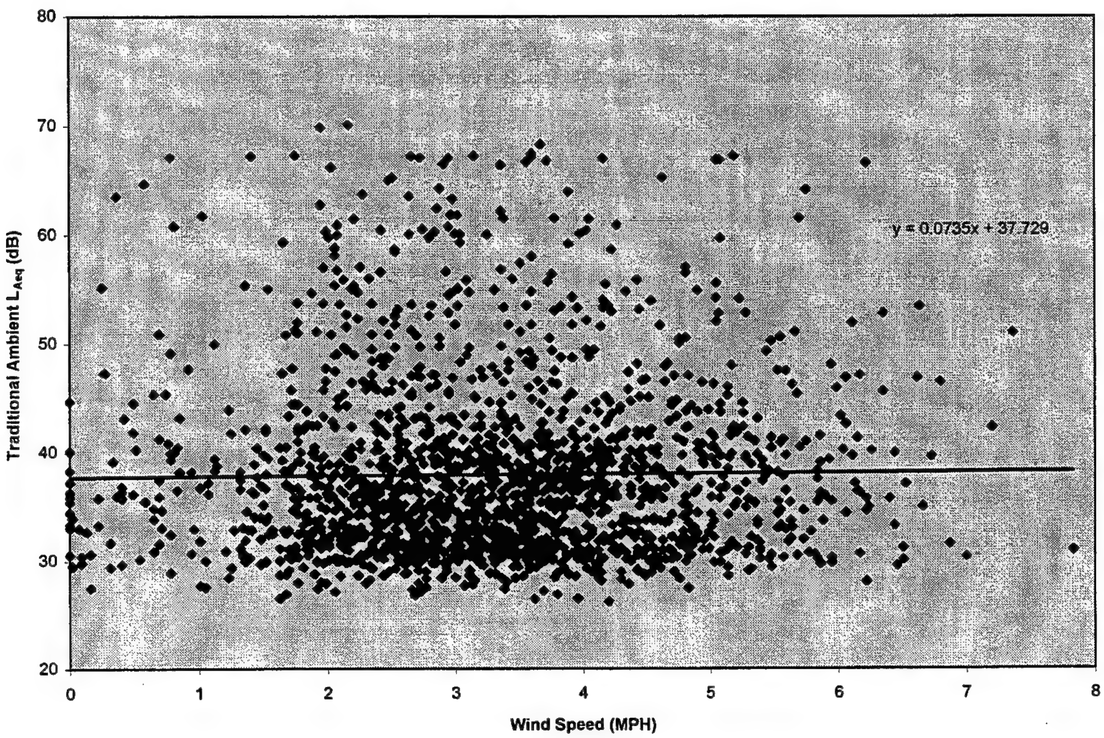


Figure 27. Traditional Ambient L_{Aeq} vs. Wind Speed: Elliott Key

6.3.4 Featherbed Bank

Featherbed Bank was a water-based site located in the Intra-Coastal Waterway where measurements were made on three separate occasions as follows: (1) Wednesday, August 12 from 14:01 to 17:00 (2 hours, 59 minutes); (2) Friday, August 14 from 08:02 to 10:55 (2 hours, 53 minutes); and (3) Saturday, August 15 from 09:42 to 12:37 (2 hours, 55 minutes). Weekday measurements were conducted in the morning and in the afternoon so as to represent a substantial portion of the daylight hours, i.e., those hours when boating activity in the Intra-Coastal was expected to be at its peak. Because of the anticipated increase in boating traffic in the Intra-Coastal on the weekend, a third measurement was conducted on Saturday, August 15 when boating activity was expected to increase.

The specific time-of-day selected for weekend measurements was chosen so as to overlap with the time-of-day associated with one of the two weekday measurements. By doing so a so-called "weekend offset" could be most easily quantified.

As can be seen from the summary data the traditional ambient sound level was fairly consistent for the two weekday measurements (49.8 versus 47.0 dB, with the lower value occurring during the morning measurements on August 14). Unexpectedly, there was no increase in the traditional ambient measured on the weekend (48.5 dB). It is interesting to point out that boat activity did markedly increase on the weekend (30.4 percent on August 12 and 30.9 percent on August 14 versus 64.6 percent on Saturday, August 15); however, this increase was not reflected in the measured sound level. On the other hand, the average wind speed was 1.9 to 2.7 mph lower on the weekend, possibly contributing to the decreased sound level. Data from the three periods were averaged as discussed in Section 5.3; and the resultant traditional ambient at Featherbed Bank was 48.8 dB.

At Featherbed Bank a wide range of wind speeds were observed (see Figure 28). In fact, a direct relationship between wind speed and wave-on-the-hull noise was observed at this site. Consequently, the computed wind effect of 1.08 dB/mph was determined to be statistically significant (assuming a 95 percent confidence interval). In accordance with Section 6.1 the wind effect at this site was classified as Category 1.

6.3.5 Fender Point

At Fender Point measurements were made on two separate days for three separate measurement periods as follows: (1) Tuesday, August 11 from 07:19 to 10:20 (3 hours, 1 minute); (2) Friday, August 14 from 07:28 to 10:30 (3 hours, 2 minutes); and (3) Friday, August 14 from 11:12 to 14:11 (2 hours, 59 minutes). Measurements were conducted in the morning and in the afternoon so as to represent a substantial portion of the daylight hours.

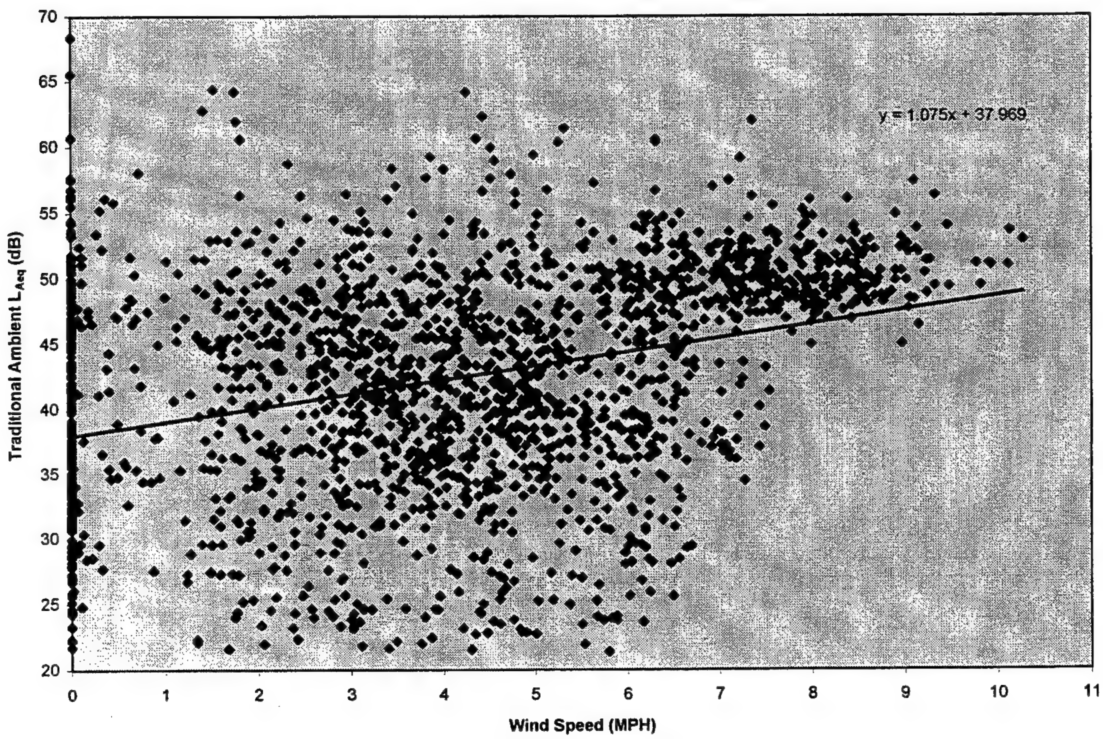


Figure 28. Traditional Ambient L_{Aeq} vs. Wind Speed: Featherbed Bank

As can be seen from the summary data, the traditional ambient sound level was fairly consistent for the measurements made on August 11 and for the afternoon measurements made on August 14 (41.1 versus 36.6 dB, respectively; however, for the morning measurements made on August 14, a substantially higher ambient sound level was measured: 50.8 dB. This increase can be attributed to a local power generator and an associated change in wind direction observed for measurements made during the morning of August 14. Although the generator was audible for measurements made on August 11 and the afternoon of August 14, the wind during the morning of August 14 consistently blew in the direction from the generator to the microphone, resulting in a substantial increase in sound level (during the morning of August 14). Data from the three periods were averaged as discussed in Section 5.3; and the resultant traditional ambient at Fender Point was 47.3 dB.

The wind effect of -1.12 dB/mph computed for Fender Point was determined to be statistically significant (assuming a 95 percent confidence interval). This may be misleading, however, due to the masking effect of other noise sources in the area, namely the previously mentioned nearby power generator. In accordance with Section 6.1 the wind effect at this site was classified as Category 3 (see Figure 29).

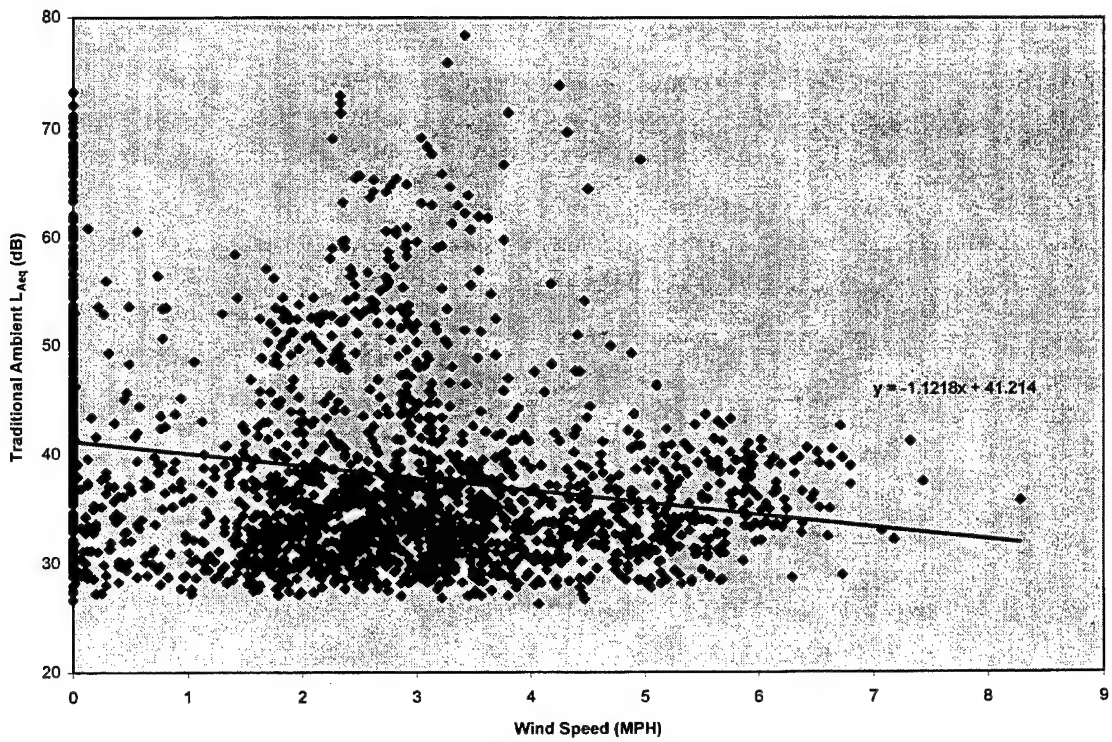


Figure 29. Traditional Ambient L_{Aeq} vs. Wind Speed: Fender Point

6.3.6 Mangrove Key

Mangrove Key was a water-based site where measurements were made on two separate occasions as follows: (1) during the nighttime period on Tuesday, August 11 from 21:24 to 00:15 (2 hours, 51 minutes); and (2) Saturday, August 15 from 07:57 to 11:42 (3 hours, 45 minutes). The reason this

site was identified by the NPS as a candidate site for nighttime measurements was that it is located adjacent to a bird sanctuary, and prior NPS research indicated birds to be especially noise-sensitive during the nighttime.

As can be seen from the summary data, the traditional ambient sound level was fairly consistent for the morning and nighttime measurements (45.1 versus 47.5 dB, with the lower value occurring during the morning measurements on August 15). For consistency with measurements performed at other sites, the nighttime data were not included in the final traditional ambient (i.e., with the exception of this site and Black Point, all the study data were measured during daytime hours). As such, the averaged traditional ambient at Mangrove Key was 45.1 dB (the same value measured for the morning measurement period).

Upon visual inspection of the data (see Figure 30), it was determined that the wind effect at this site did not appear to behave in a linear fashion. Specifically, when the wind speed was 5 mph or below, the average ambient level was 34.1 dB. When the wind speed was above 5 mph, waves began hitting the side of the boat, masking other ambient noise sources and increasing the ambient level to 47.4 dB. In terms of categorization of the wind effect, this site was an exception, and none of the categories discussed in Section 6.1 applied.

6.3.7 Pacific Reef

Pacific Reef was a water-based site on the southeastern boundary of BNP where measurements were made on two separate occasions as follows: (1) Tuesday, August 11 from 11:01 to 15:41 (4 hours, 40 minutes); and (2) Sunday, August 16 from 09:14 to 12:14 (3 hours). Weekday measurements were conducted so as to represent a substantial portion of the daylight hours, i.e., those hours when boating activity around the reef was expected to be at its peak. Because of the anticipated increase in boating traffic around the reef on the weekend, a second measurement was conducted on Sunday, August 16.

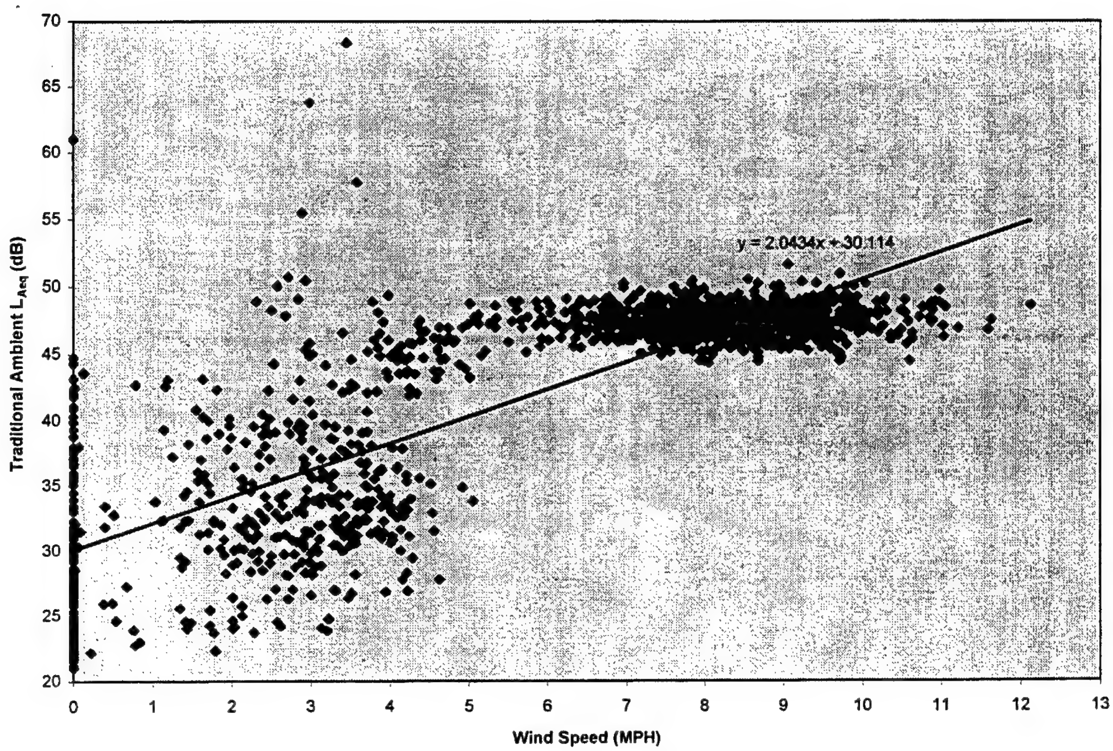


Figure 30. Traditional Ambient L_{Aeq} vs. Wind Speed: Mangrove Key

The specific time-of-day selected for weekend measurements was chosen so as to overlap with the time-of-day associated with a portion of the weekday measurements. By doing so a so-called "weekend offset" could be most easily quantified.

As can be seen from the summary data, an approximate 5 dB increase in the traditional ambient was measured on the weekend (53.9 dB versus 49.2 dB during the week). This increase can be directly attributed to the increased visitor volume associated with increased boating activity on the weekend. In fact, the percent of time boats (or boat-related activity, e.g., boat radios or fishing-related activity) were audible increased from 27 percent during the week to 42 percent on the weekend. In addition,

the average wind speed was 1.7 mph higher on the weekend, also possibly contributing to the increased sound level. Data from the two periods were averaged as discussed in Section 5.3; and the resultant traditional ambient at Pacific Reef was 50.6 dB.

At Pacific Reef, a wide range of wind speeds was observed (see Figure 31). In fact, a direct relationship between wind speed and wave-on-the-hull noise was observed at this site. Consequently, the computed wind effect of 1.72 dB/mph was determined to be statistically significant (assuming a 95 percent confidence interval). In accordance with Section 6.1 the wind effect at this site was classified as Category 1.

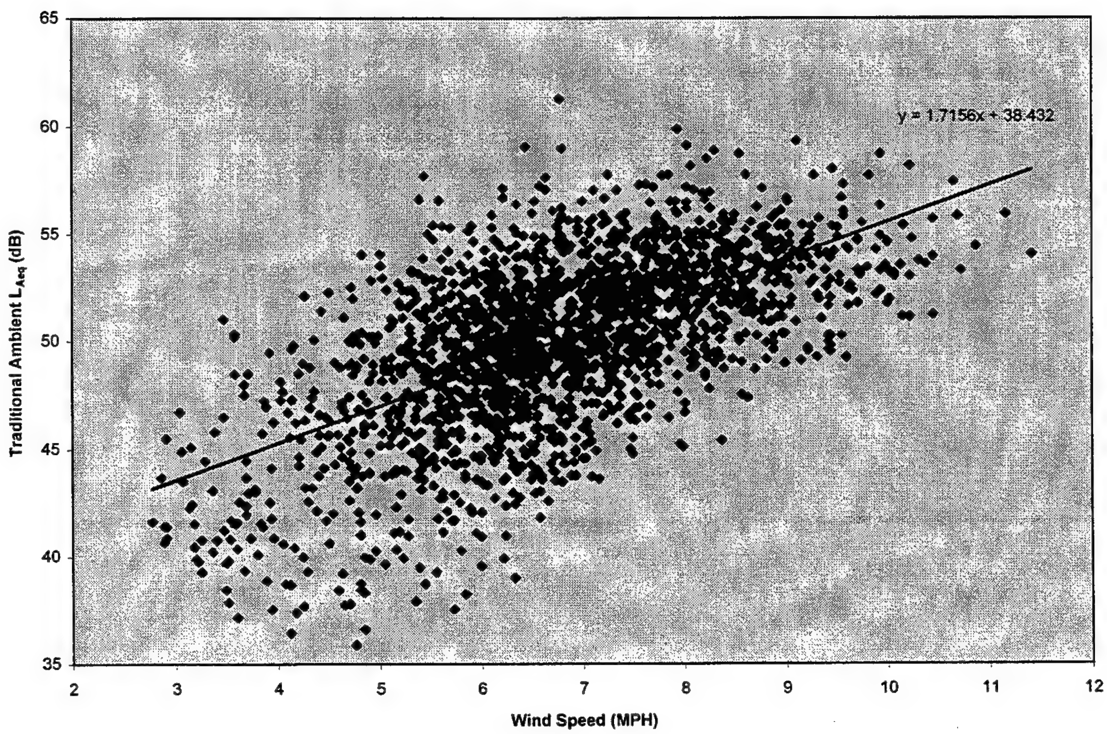


Figure 31. Traditional Ambient L_{Aeq} vs. Wind Speed: Pacific Reef

6.3.8 Rubicon Key

Rubicon Key was a water-based site where measurements were made on two separate occasions as follows: (1) Tuesday, August 11 from 08:02 to 11:01 (2 hours, 59 minutes); and (2) Friday, August 14 from 12:47 to 15:38 (2 hours, 51 minutes). Weekday measurements were conducted so as to represent a substantial portion of the daylight hours, i.e., those hours when boating activity was expected to be at its peak.

As can be seen from the summary data, the traditional ambient sound level was extremely consistent for the two weekday measurements (49.5 versus 51.3 dB, with the slightly lower value occurring during the morning measurements on the August 11). Data from the two time periods were averaged as discussed in Section 5.3; and the resultant traditional ambient at Rubicon Key was 50.6 dB.

At Rubicon Key a direct relationship between wind speed and wave-on-the-hull noise was observed (see Figure 32). Consequently, the computed wind effect of 1.42 dB/mph was determined to be statistically significant (assuming a 95 percent confidence interval). In accordance with Section 6.1 the wind effect at this site was classified as Category 1.

6.3.9 Soldier Key

At Soldier Key, measurements were made on two separate occasions as follows: (1) Thursday, August 13 from 10:50 to 13:32 (2 hours, 42 minutes); and (2) Sunday, August 16 from 09:42 to 12:43 (3 hours, 1 minute). Weekday measurements were conducted so as to represent a substantial portion of the daylight hours, i.e., those hours when park visitation was expected to be at its peak. In addition, day-to-day variation in boating activity was of particular concern at Soldier Key. Consequently, measurements were also conducted on the weekend when boating activity was expected to increase. The specific time-of-day selected for weekend measurements was chosen so as to overlap with the time-of-day associated with one of the measurements. By doing a so-called "weekend offset" could be most easily quantified.

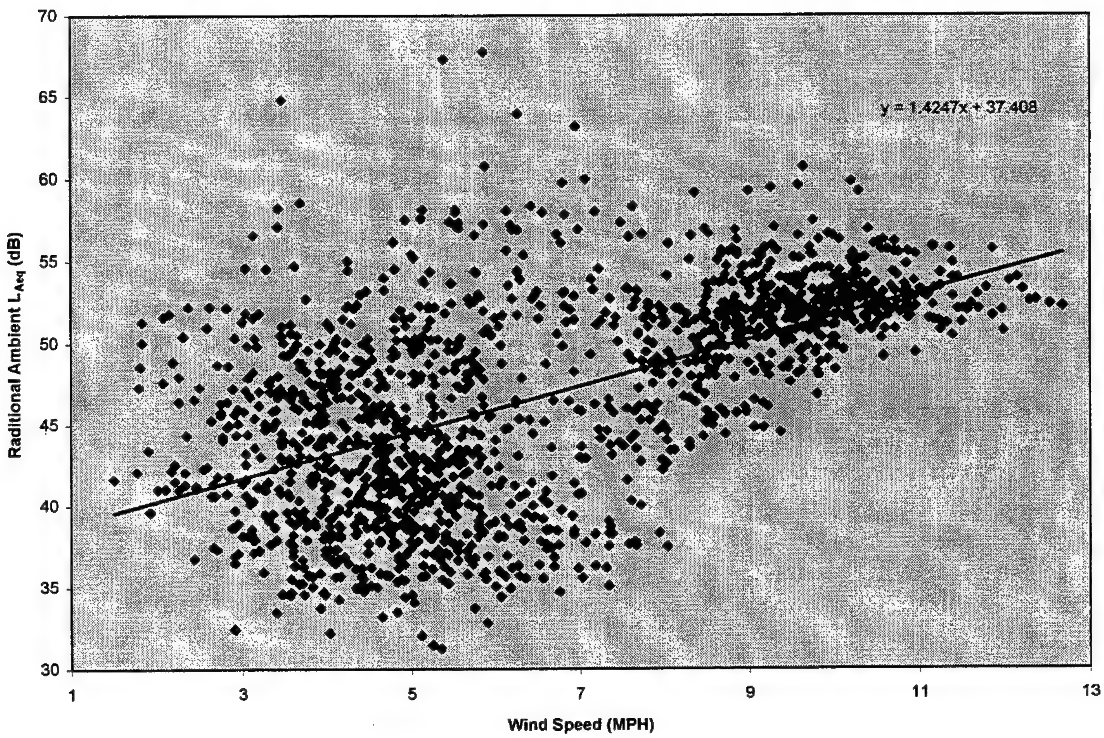


Figure 32. Traditional Ambient L_{Aeq}vs. Wind Speed: Rubicon Key

As can be seen, an approximate 4 dB increase in the traditional ambient was measured on the weekend (60.7 dB versus 56.5 dB during the week). This increase can be directly attributed to the increased boating activity around the Key. In fact, the percent time boats (or boat related activity, e.g., jet skis) were audible increased from 19.8 percent during the week to 40.9 percent on the weekend. In addition, the average wind speed was 1.4 mph higher on the weekend, also possibly contributing to the increased sound level. Data from the two periods were averaged as discussed in Section 5.3; and the resultant traditional ambient at Soldier Key was 58.7 dB. One notable observation at Soldier Key which helps to explain the unusually high ambient was the substantial contribution to the sound level from insect activity. Because of the hierarchy associated with the

acoustic data logging process, natural/insects was rarely logged at Soldier Key (i.e., when the more common aircraft or other human-made sounds were audible); however, in the vast majority of the comments made in the acoustic data logs maintained for Soldier Key, insect-related noises were qualitatively identified as contributing to the measured sound level.

The wind effect of 3.48 dB/mph at Soldier Key was determined to be statistically significant (assuming a 95 percent confidence interval). This may be misleading, however, due to the masking effect of other noise sources in the area, namely insects. In accordance with Section 6.1 the wind effect at this site was classified as Category 3 (see Figure 33).

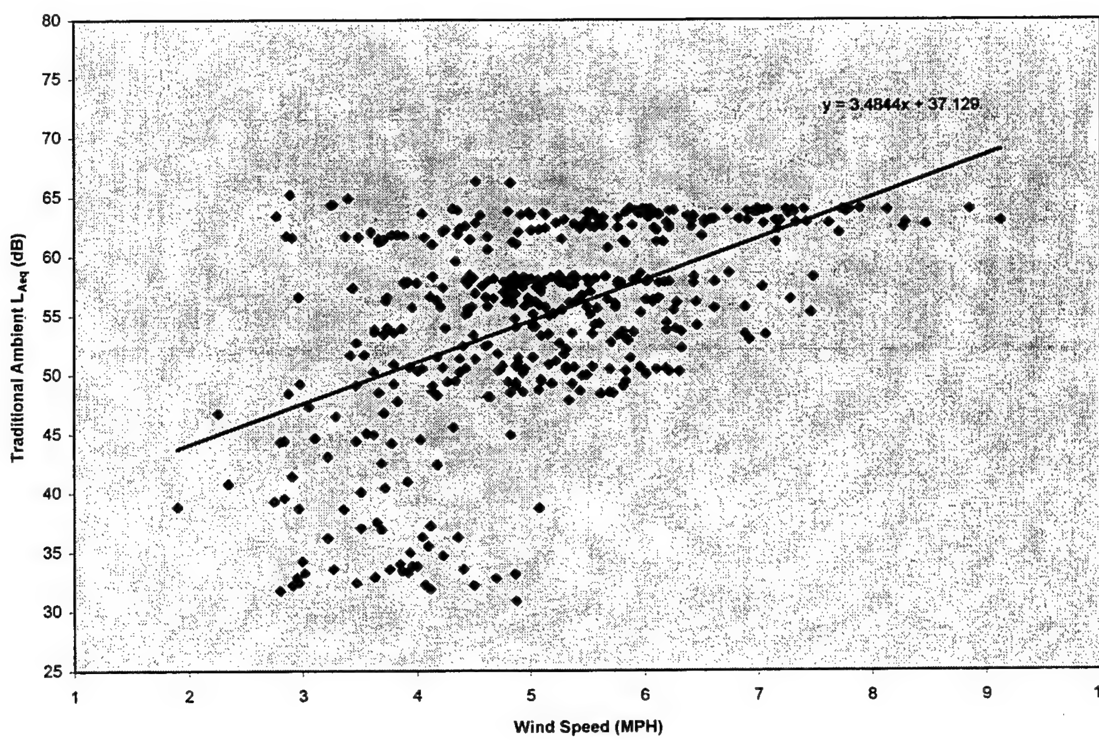


Figure 33. Traditional Ambient L_{Aeq} vs. Wind Speed: Soldier Key

6.3.10 Stiltsville

Stiltsville was a water-based site located in the Intra-Coastal Waterway where measurements were made on three separate occasions as follows: (1) Wednesday, August 12 from 09:34 to 12:34 (2 hours, 59 minutes, with an approximate one-minute lapse in data collection due to an anomalous radio broadcast); (2) Sunday, August 16 from 14:15 to 17:12 (2 hours, 57 minutes); and (3) Monday, August 17 from 09:04 to 12:02 (2 hours, 58 minutes). Weekday measurements were conducted so as to encompass a substantial portion of the daylight hours, i.e., those hours when boating activity in the Intra-Coastal was expected to be at its peak. Because of the anticipated increase in boating traffic in the Intra-Coastal on the weekend, a third measurement was conducted on Sunday, August 16 when boating activity was expected to increase. Unfortunately, due to scheduling constraints, weekend measurements could not be conducted during a time-of-day similar to those times associated with the two weekday measurements.

As can be seen from the summary data, the traditional ambient sound level was extremely consistent for the two weekday measurements (53.4 on August 12 versus 54.1 dB on August 17). However, an approximate 3 dB increase was measured on the weekend (57.2 dB). This increase can be directly attributed to the increased visitor volume associated with increased boating activity. Unfortunately, this observation cannot be supported with quantifiable data. Specifically, because of the hierarchy associated with the acoustic data logging process, human/boats was rarely logged at Stiltsville because of the site's close proximity to MIA (and by default because of the large amount of observed aircraft); however, in the vast majority of the comments made in the acoustic data logs maintained for the site, boat-related noises were qualitatively identified as contributing substantially to the measured sound level. Data from the three periods were averaged as discussed in Section 5.3; and the resultant traditional ambient at Stiltsville was 54.9 dB.

At Stiltsville, a wide range of wind speeds was observed (see Figure 34). In fact, a direct relationship

between wind speed and wave-on-the-hull noise was observed at the site. Consequently, the computed wind effect of 0.91 dB/mph was determined to be statistically significant (assuming a 95 percent confidence interval). In accordance with Section 6.1 the wind effect at this site was classified as Category 1.

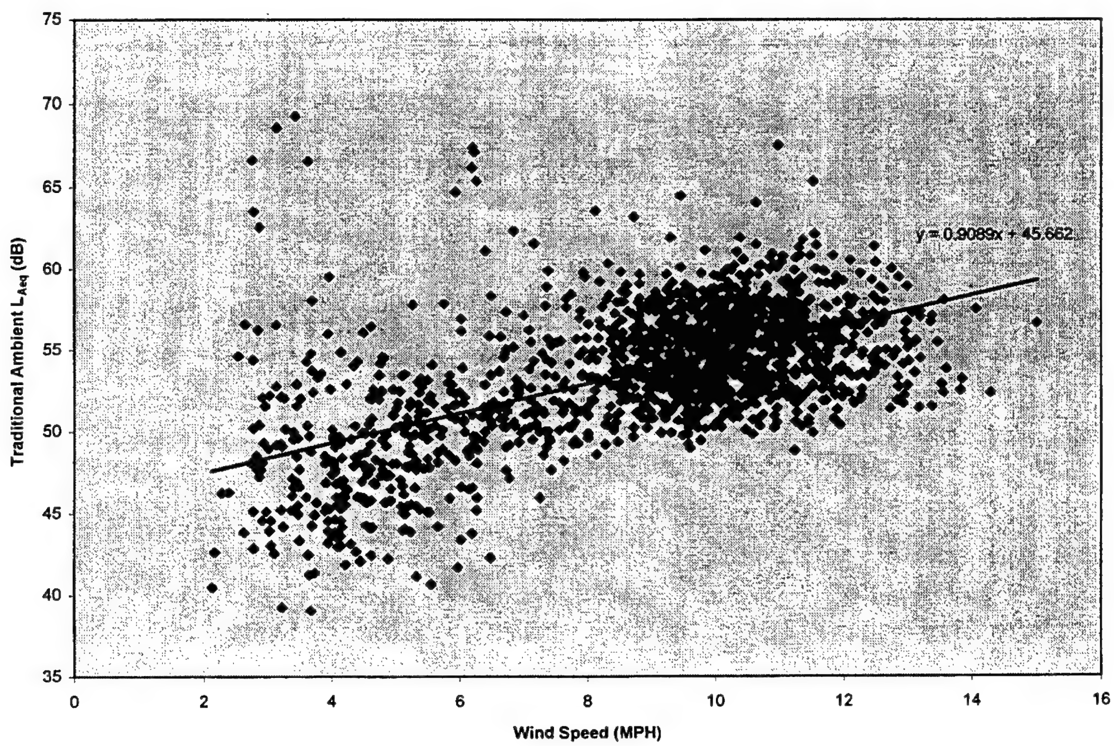


Figure 34. Traditional Ambient L_{Aeq} vs. Wind Speed: Stiltsville

6.3.11 Visitor Center

At BNP Visitor Center, measurements were made on two separate occasions as follows: (1) Tuesday, August 11 from 11:38 to 14:38 (3 hours); and (2) Sunday, August 16 from 14:57 to 18:01 (3 hours, 4 minutes). Weekday measurements were conducted so as to represent a substantial portion of the daylight hours, i.e., those hours when park visitation was expected to be at its peak. Obviously,

visitor activity was of particular concern at the Center. Consequently, measurements were also conducted on Sunday, August 16 when visitation was expected to increase. Unfortunately, due to scheduling constraints, weekend measurements could not be conducted during a time-of-day similar to those times associated with the weekday measurement.

As can be seen, an approximate 10 dB ***decrease*** in the traditional ambient was measured on the weekend (48.7 dB versus 59.0 dB during the week). This decrease on the weekend can be directly attributed to visitor activity during the week. Specifically, measurements at the Visitor Center on August 11 were dominated by contributions from activity associated with a local school outing. Specifically, the majority of the data were measured while school children were canoeing around the BNP Visitor Center. This is an example of how variable the sound level can be at some of the more developed measurement sites. Data from the two periods were averaged as discussed in Section 5.3; and the resultant traditional ambient at the BNP Visitor Center was 57.4 dB.

The wind effect of -1.63 dB/mph at the Visitor Center was determined to be statistically significant (assuming a 95 percent confidence interval). This may be misleading, however, due to the masking effect of other noise sources in the area, namely human voices, land-based vehicles, and water-based vehicles. In accordance with Section 6.1 the wind effect at this site was classified as Category 3 (see Figure 35).

6.4 Everglades National Park

This section presents a discussion of the traditional ambient sound level data measured at the thirteen ENP sites. The sites are presented in alphabetical order.

6.4.1 Anhinga Trail

On Anhinga Trail, measurements were made on three separate occasions as follows: (1) Monday, August 10 from 15:22 to 18:22 (3 hours); (2) Wednesday, August 12 from 07:57 to 10:56 (2 hours, 59 minutes); and (3) Saturday, August 15 from 07:33 to 10:07 (2 hours, 34 minutes). Weekday measurements were conducted so as to represent a substantial portion of the daylight hours, i.e., those hours when park visitation was expected to be at its peak. Obviously, visitor activity was of particular concern on Anhinga Trail because of its close proximity to the Royal Palm Visitor Center. Consequently, measurements were also conducted on Saturday, August 15 when visitor volume was expected to increase. The specific time-of-day selected for weekend measurements was chosen so as to overlap with the time-of-day associated with one of the two weekday measurements. By doing so, a so-called "weekend offset" could be most easily quantified.

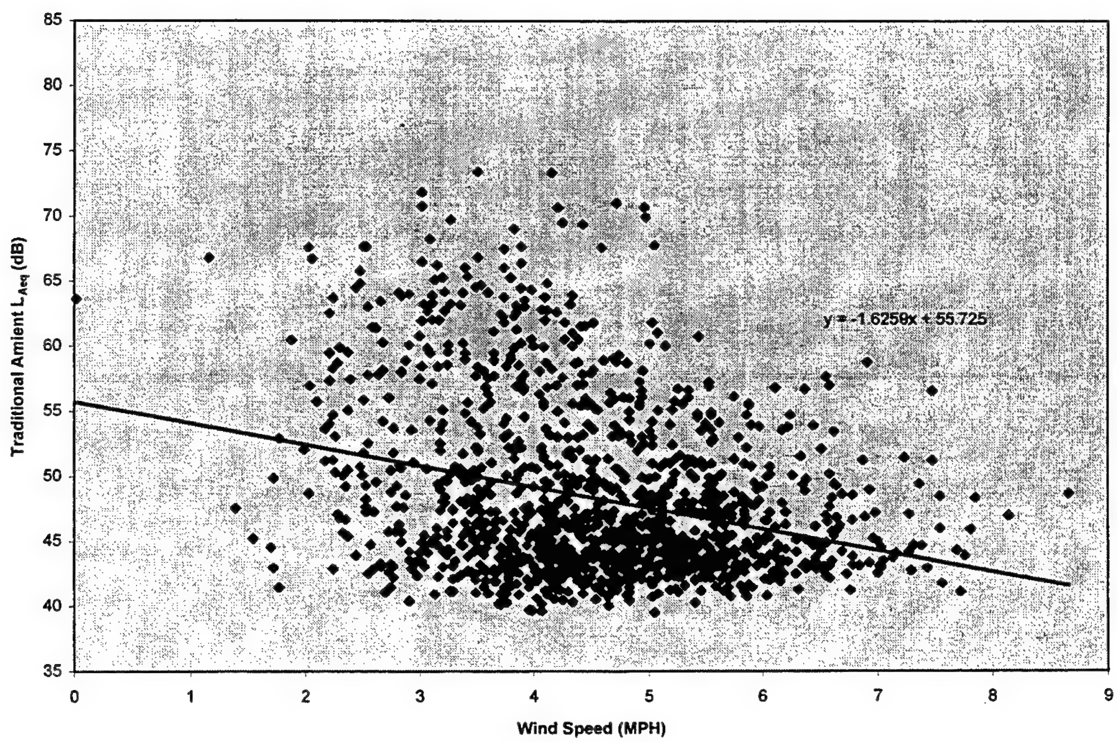


Figure 35. Traditional Ambient L_{Aeq} vs. Wind Speed: Visitor Center

As can be seen from the summary data, the ambient sound level was not at all consistent for the two weekday measurements (40.8 dB versus 58.8 dB, with the lower value measured during the afternoon segment). This apparent anomaly is best explained by the example time history data presented in Figure 36. Specifically, in this figure and during the majority of the measurements conducted on August 12, a gasoline-powered lawn trimmer was observed. This trimmer is the source of the increased sound level associated with the measurements on August 12. Because the trimmer was audible during almost the entire measurement period, its specific contribution to the measured sound level could not be accurately quantified. However, expectations are that a level similar to the 40.8 dB level measured on August 10 would have been obtained if the trimmer had not been in operation. Regardless, there was no technical basis for excluding the August 12 data, since trimming and landscaping would have to be conducted periodically anyway. The traditional ambient measured on the weekend fell in between the two weekday measurements (52.0 dB). Data from the three measurements were averaged as discussed in Section 5.3; and the resultant traditional ambient on Anhinga Trail was 55.4 dB.

The wind effect of 0.38 dB/mph on the Anhinga Trail was determined to be statistically significant (assuming a 95 percent confidence interval). This may be misleading, however, because the majority of data were measured at wind speeds below 5 mph (see Figure 37). In accordance with Section 6.1, the wind effect at this site was classified as Category 2.

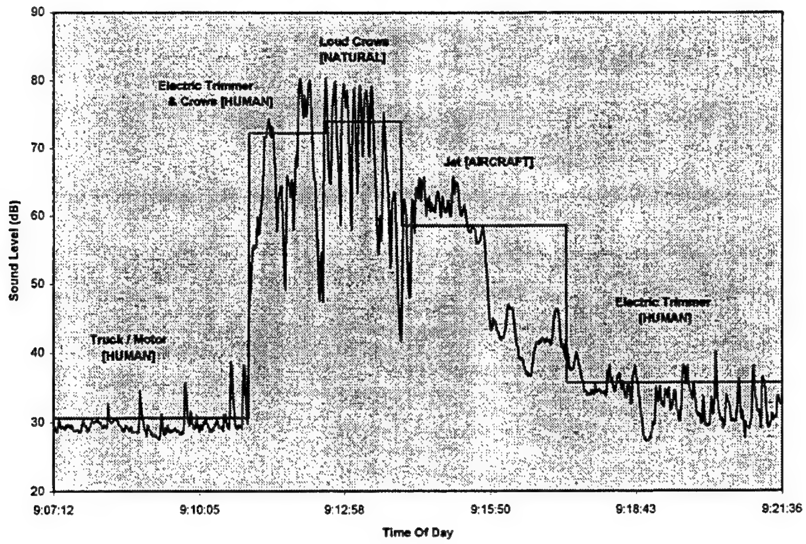


Figure 36. Example Sound Level Time History for 8/12/98: Anhinga Trail

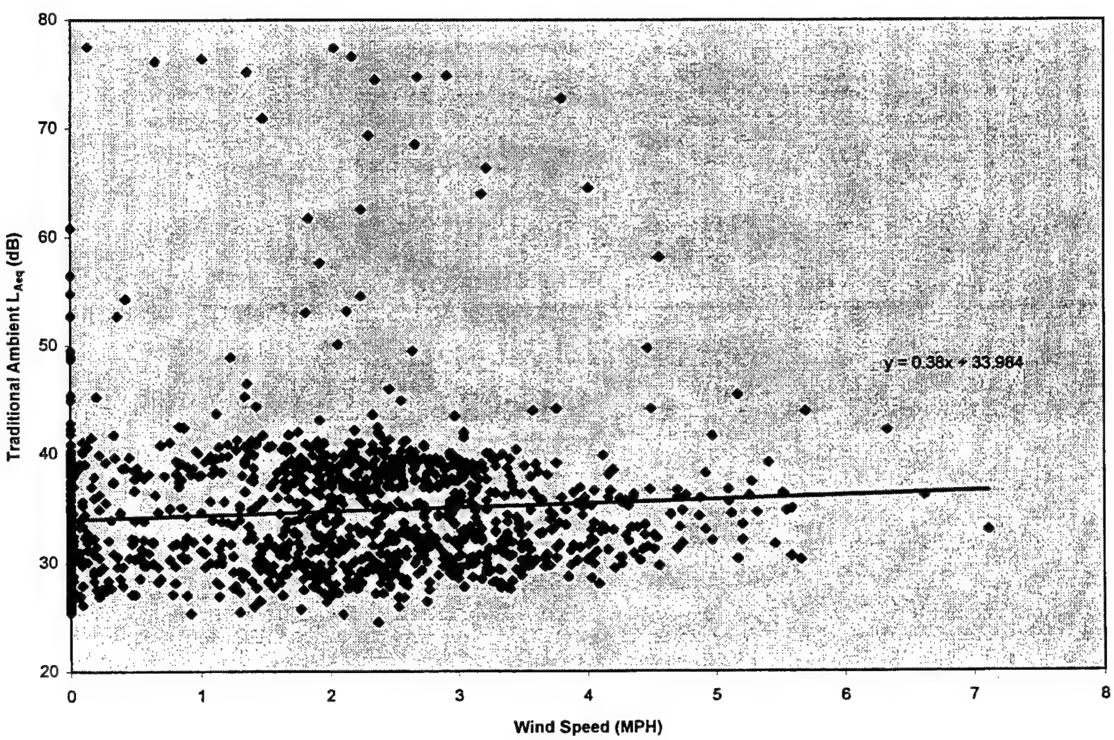


Figure 37. Traditional Ambient L_{Aeq} vs. Wind Speed: Anhinga Trail

6.4.2 Buchanan Key

Buchanan Key was a water-based site in Florida Bay where, due to logistics measurements were only conducted on one occasion, but for some five hours, as follows: (1) Wednesday, August 19 from 10:50 to 15:53 (4 hours, 55 minutes, with an approximate seven minute lapse in data collection due to excessively high winds). The measurements were conducted so as to encompass a substantial portion of the daylight hours, i.e., those hours when boating activity in Florida Bay was expected to be at its peak. It is important to point out that the data collected at Buchanan Key were measured under extremely high wind conditions. Specifically, the average wind speed at the site was 14.6 mph, with a maximum of 20.8 mph. Because of concern associated with potential data contamination at high wind speeds, the DAT tapes recorded at Buchanan Key were carefully monitored. As a result of the monitoring process, some 450 seconds (7½ minutes) of data were eliminated from the average. Although the contamination associated with wind noise could be audibly detected, it was qualitatively observed to be much lower in level than other recorded sounds.

The traditional ambient at Buchanan Key was 45.8 dB.

At Buchanan Key a wide range of wind speeds were observed (see Figure 38). In fact, a direct relationship between wind speed and wave-on-the-hull noise was observed at this site. Consequently, the computed wind effect of 0.32 dB/mph was determined to be statistically significant (assuming a 95 percent confidence interval). In accordance with Section 6.1, the wind effect at this site was classified as Category 1.

6.4.3 Chekika

At Chekika, measurements were made on two separate occasions as follows: (1) Monday, August 10 from 08:53 to 13:04 (4 hours, 11 minutes); and (2) Monday, August 17 from 16:21 to 18:22 (2 hours, 1 minute). The measurements were conducted so as to encompass a substantial portion of the daylight hours.

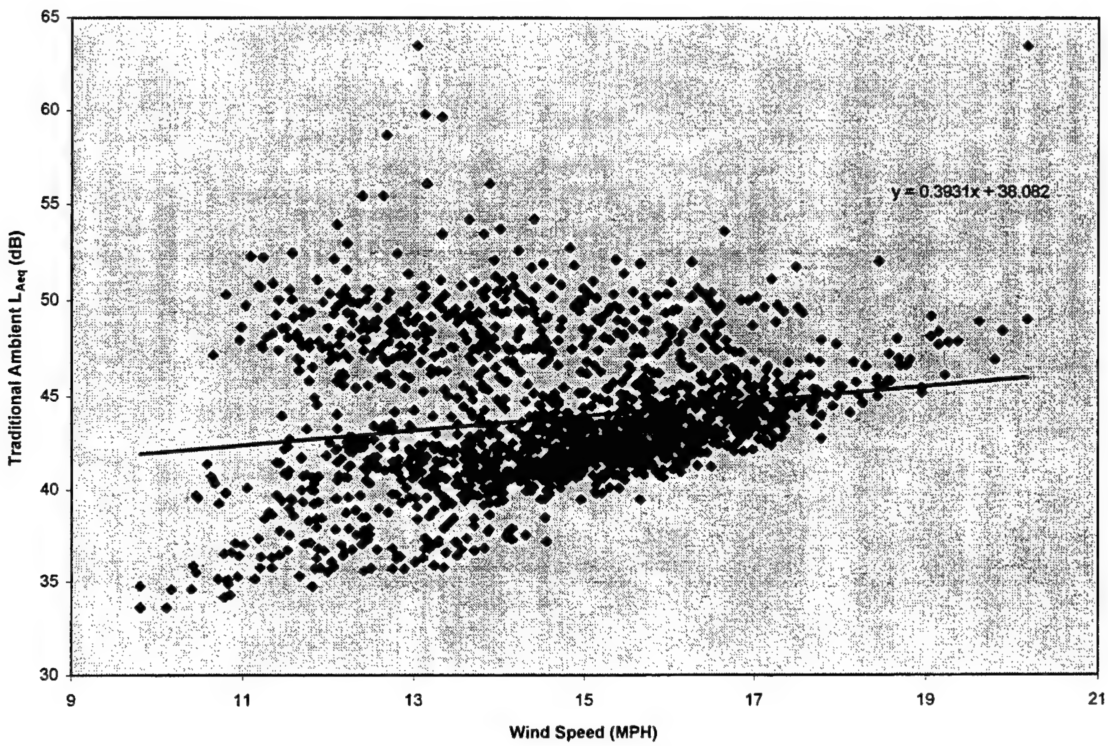


Figure 38. Traditional Ambient L_{Aeq} vs. Wind Speed: Buchanan Key

As can be seen from the summary data, the traditional ambient sound level was extremely consistent for the two measurements (41.3 versus 40.2 dB, with the slightly lower value occurring during the afternoon measurements on August 17). Data from the two periods were averaged as discussed in Section 5.3; and the resultant traditional ambient at Chekika was 41.0 dB.

Chekika was a heavily vegetated site, surrounded by dense saw grass. Consequently, the computed wind effect of 0.93 dB/mph was determined to be statistically significant (assuming a 95 percent

confidence interval). In accordance with Section 6.1, the wind effect at this site was classified as Category 1 (see Figure 39).

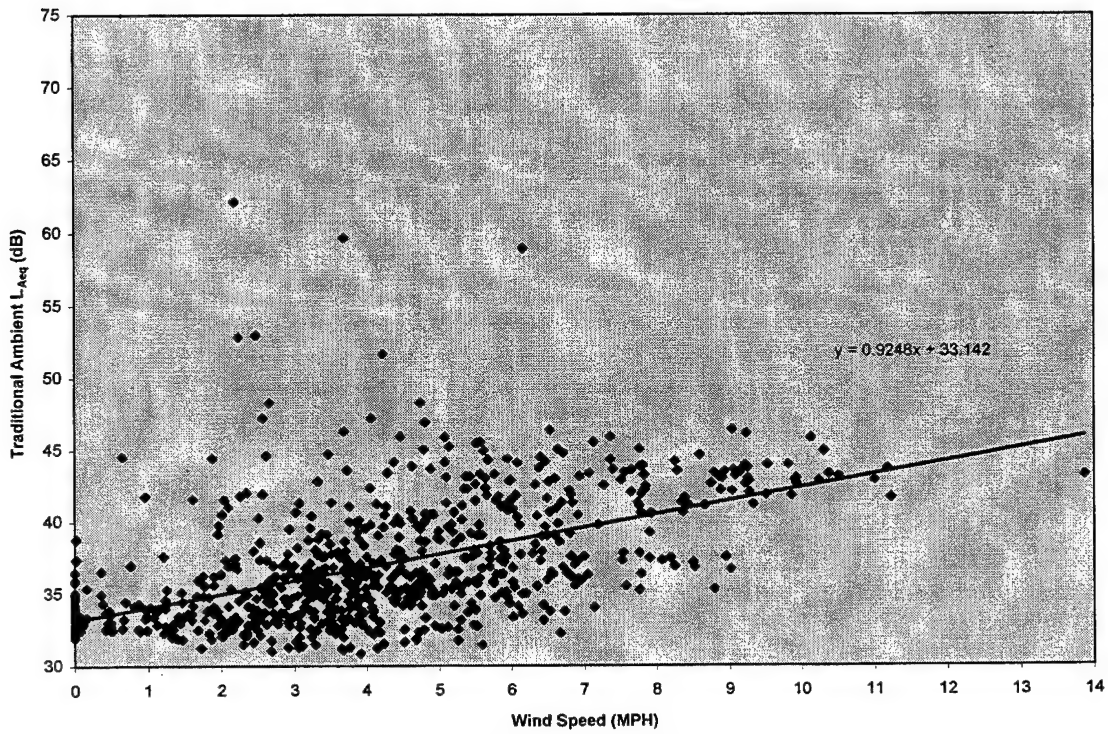


Figure 39. Traditional Ambient L_{Aeq} vs. Wind Speed: Chekika

6.4.4 Eastern Panhandle

Eastern Panhandle was a measurement site which was just 1/4-mi east of Route 1. Because of its proximity to a highly-dominant localized noise source, measurements were only conducted on one occasion: Thursday, August 13 from 12:31 to 15:25 (2 hours, 54 minutes). In fact, the only reason this site was included in the study was because it was considered essential to the NPS.

The traditional ambient at Eastern Panhandle was 54.9 dB.

The wind effect of -0.41 dB/mph at Eastern Panhandle was determined to be statistically significant (assuming a 95 percent confidence interval). This is misleading due to the contaminating effect of Route 1. In fact, higher wind speeds resulted in lower ambient noise levels because the predominant wind during measurements was in the direction of Route 1, i.e., as wind speeds increased the contribution to the measured ambient due to Route 1 decreased (see Figure 40). In accordance with Section 6.1, the wind effect at this site was classified as Category 3.

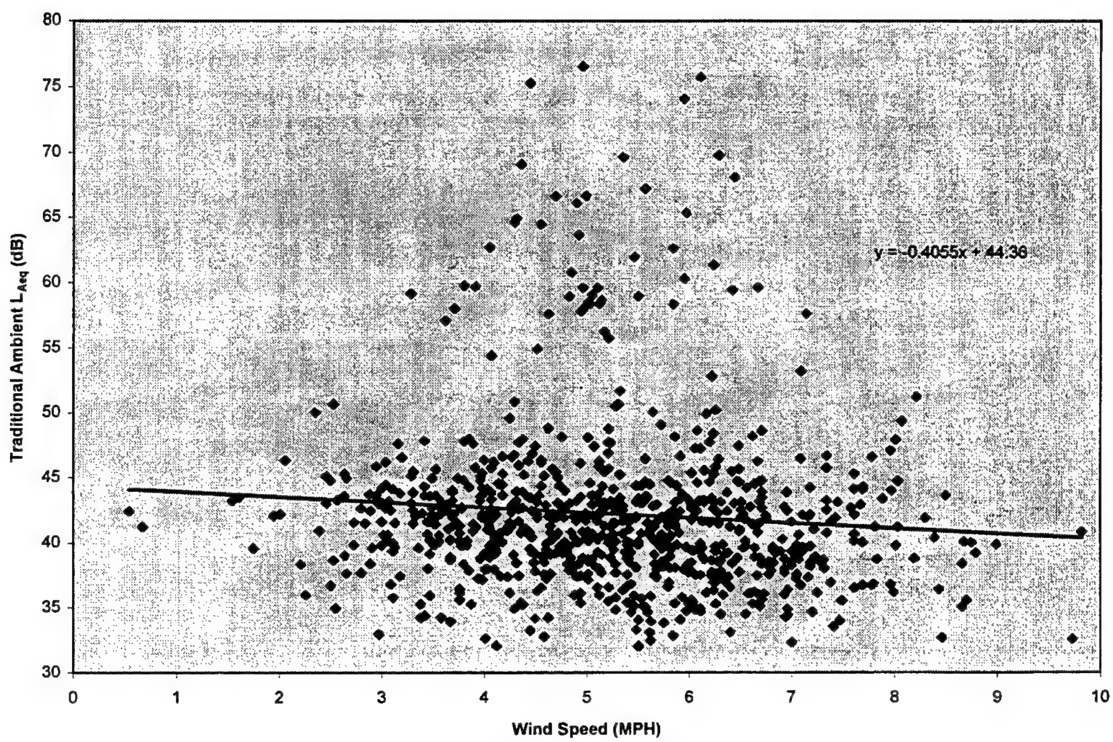


Figure 40. Traditional Ambient L_{Aeq} vs. Wind Speed: Eastern Panhandle

6.4.5 Eastern Sparrow

Eastern Sparrow was a remote site accessible via helicopter only. Consequently, measurements were only conducted on one occasion, but for some five hours as follows: Tuesday, August 18 from 09:41

to 15:01 (5 hours, 11 minutes, with an approximate seven minute lapse in data collection due to precipitation). The measurements were conducted so as to encompass a substantial portion of the daylight hours.

The traditional ambient at Eastern Sparrow was 31.2 dB, the lowest of all the measurement sites included in this study. Unlike the majority of the other measurement sites included in the study, at Eastern Sparrow there was a substantial difference in the traditional ambient as compared to the existing ambient, with the traditional some 17.5 dB lower in level. The reason for this difference can be attributed to two factors: (1) Eastern Sparrow is a low-sound level, extremely remote site where the sounds of nature tend to dominate the ambient, and as such any aircraft activity would tend to be significantly higher in level relative to other sounds; and (2) during measurements at Eastern Sparrow a fairly high percentage of time was dominated by audible aircraft (over 50 percent), some of which were military aircraft of extremely high sound level.

Eastern Sparrow was a heavily vegetated site, surrounded by dense saw grass. Consequently, the computed wind effect of 1.49 dB/mph was determined to be statistically significant (assuming a 95 percent confidence interval). It is interesting to point out that the wind effect does not appear to be readily apparent for speeds below about 5 mph (see Figure 41). In accordance with Section 6.1, the wind effect at this site was classified as Category 1.

6.4.6 Eco Pond

Eco Pond was a relatively remote site in the southern portion of ENP. Consequently, measurements were only conducted on one occasion, but for some six hours as follows: (1) Friday, August 14 from 08:45 to 14:51 (5 hours, 54 minutes, with an approximate nine minute lapse in data collection due to data download). The measurements were conducted so as to encompass a substantial portion of the daylight hours.

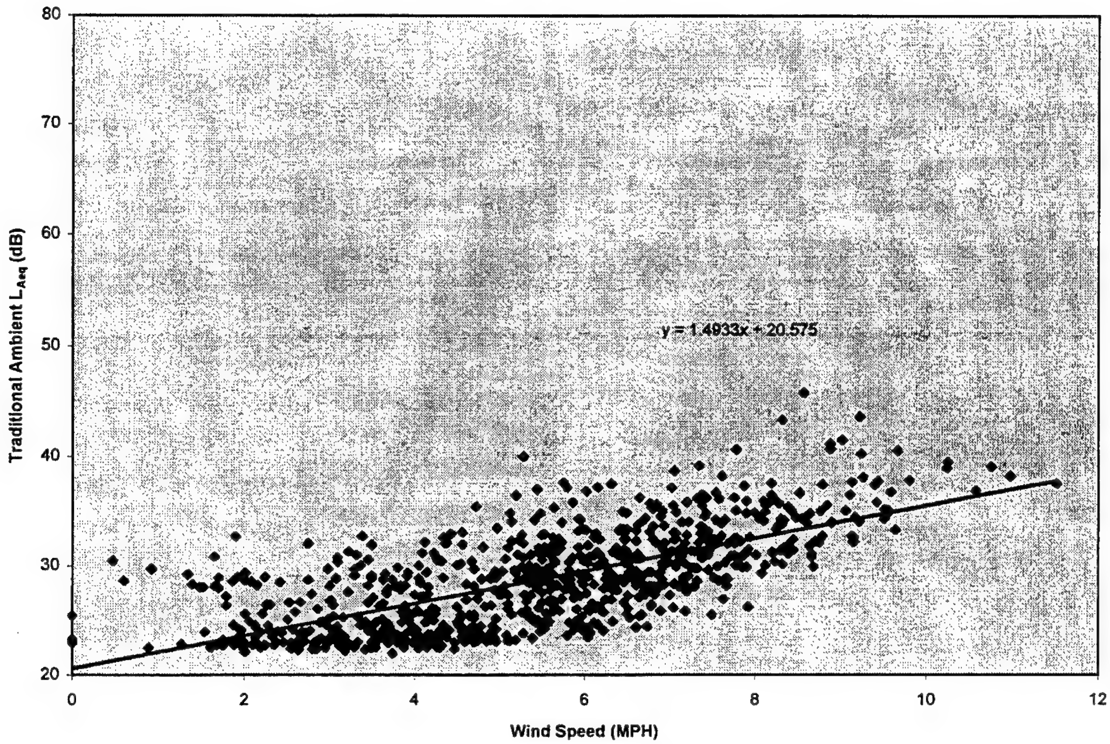


Figure 41. Traditional Ambient L_{Aeq}vs. Wind Speed: Eastern Sparrow

The traditional ambient at Eco Pond was 48.3 dB.

Eco Pond was a heavily vegetated site, and a substantial positive wind effect was expected to be observed. However, a wind effect of -0.69 dB/mph was computed, and it was determined to be statistically significant (assuming a 95 percent confidence interval). However, this may be misleading because the majority of data were measured at wind speeds below 5 mph (see Figure 42). In accordance with Section 6.1 the wind effect at this site was classified as Category 2.

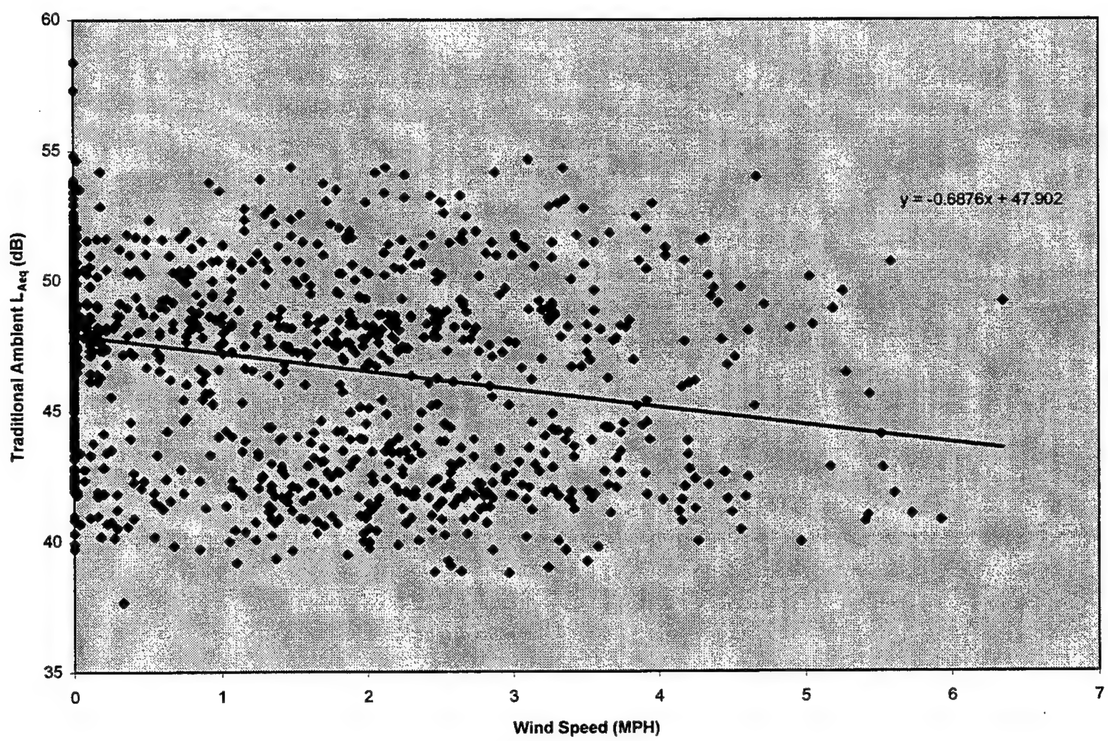


Figure 42. Traditional Ambient L_{Aeq} vs. Wind Speed: Eco Pond

6.4.7 Hidden Lake

At Hidden Lake, measurements were made on two separate occasions as follows: (1) Saturday, August 15 from 11:55 to 15:04 (3 hours, 9 minutes); and (2) Monday, August 17 from 16:45 to 18:35 (1 hour, 48 minutes, with an approximate three minute lapse in data collection due to precipitation). The measurements were conducted so as to encompass a substantial portion of the daylight hours.

As can be seen from the summary data, the traditional ambient sound level was extremely consistent for the two measurements (35.7 versus 36.1 dB, with the slightly higher value occurring during the late afternoon measurements on August 17). Data from the two measurements were averaged as discussed in Section 5.3; and the resultant traditional ambient at Hidden Lake was 36.0 dB.

Hidden Lake was a heavily vegetated site, surrounded by dense hammock. Consequently, the computed wind effect of 0.72 dB/mph was determined to be statistically significant (assuming a 95 percent confidence interval). However, this may or may not be misleading because the majority of data were measured at wind speeds below 5 mph (see Figure 43). In accordance with Section 6.1, the wind effect at this site was conservatively classified as Category 2; however, it is very possible that the computed wind effect was ***real*** and that a Category 1 classification may be more appropriate.

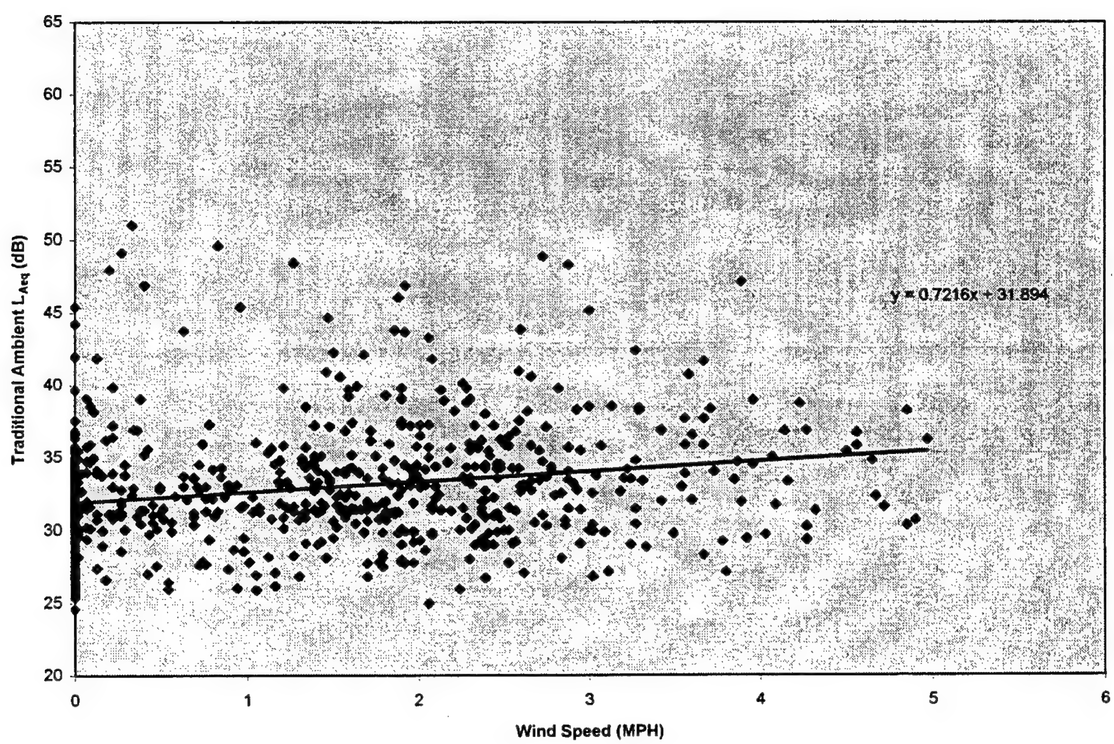


Figure 43. Traditional Ambient L_{Aeq} vs. Wind Speed: Hidden Lake

6.4.8 Little Madeira Bay

Little Madeira Bay was an extremely remote water-based site where measurements were made on two separate occasions as follows: (1) Tuesday, August 18 from 08:32 to 11:37 (3 hours, 5 minutes); and (2) Thursday, August 20 from 10:48 to 12:14 (1 hour, 26 minutes).

As can be seen from the summary data, the ambient sound level, which was dominated primarily by wave noise against the hull of the measurement boat, was relatively consistent for the two weekday measurements (47.5 versus 44.4 dB). Data from the two periods were averaged as discussed in Section 5.3; and the resultant traditional ambient at Little Madeira Bay was 46.7 dB.

Little Madeira Bay was a water-based site at which an extremely wide range of wind speeds was observed (see Figure 44). The computed wind effect of -0.15 dB/mph was determined to be statistically significant (assuming a 95 percent confidence interval). However, upon further investigation, it was found that the data from individual days made up two distinct data sets. When a linear function was fitted to each data set separately, it was found that the wind effect from each day was similar; 0.52 dB/mph for measurements made on 8/18/98 and 0.64 dB/mph for measurements made on 8/20/98. Therefore, a duration-weighted average of these values was calculated, resulting in a wind effect of 0.56 dB/mph for this site. In accordance with Section 6.1, the final wind effect for the two separate days at this site was classified as Category 1.

6.4.9 North Nest Key

North Nest Key was a remote site located in the southern portion of Florida Bay. Measurements were only conducted on one occasion as follows: Tuesday, August 18 from 14:34 to 17:28 (2 hours, 54 minutes).

The traditional ambient at North Nest Key was 39.8 dB.

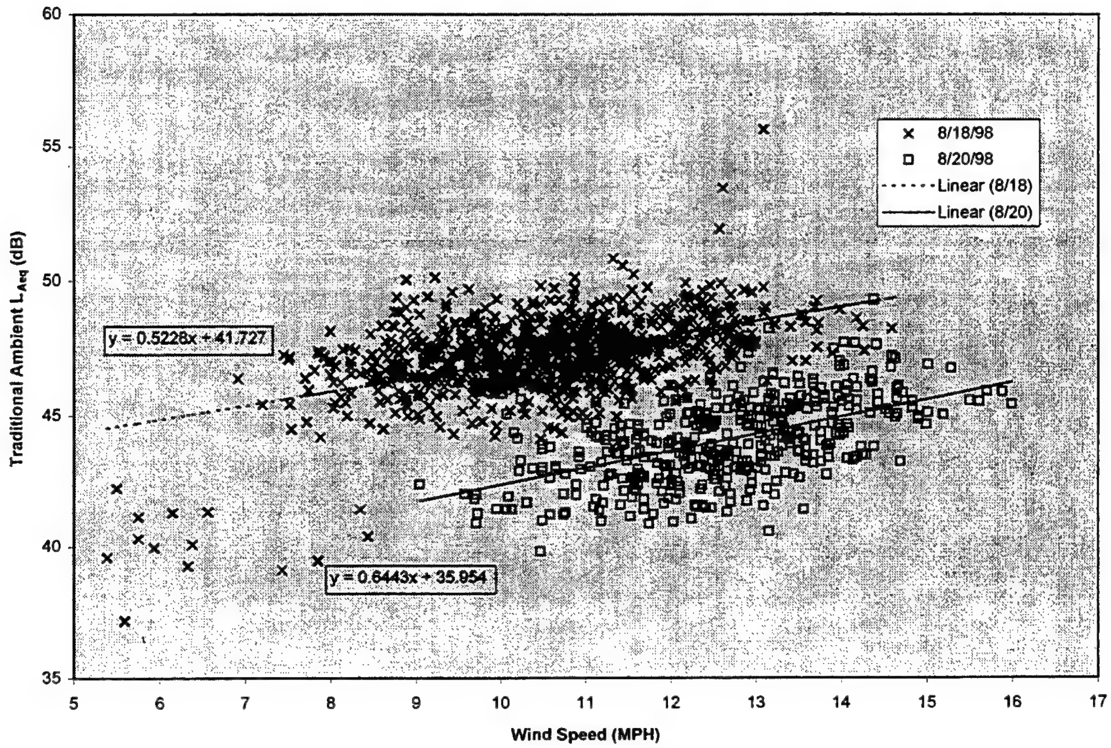


Figure 44. Traditional Ambient L_{Aeq} vs. Wind Speed: Little Madeira Bay

North Nest Key was a heavily vegetated site, surrounded by dense mangrove. Consequently, the computed wind effect of 0.74 dB/mph was determined to be statistically significant (assuming a 95 percent confidence interval). In accordance with Section 6.1, the wind effect at this site was classified as Category 1 (see Figure 45).

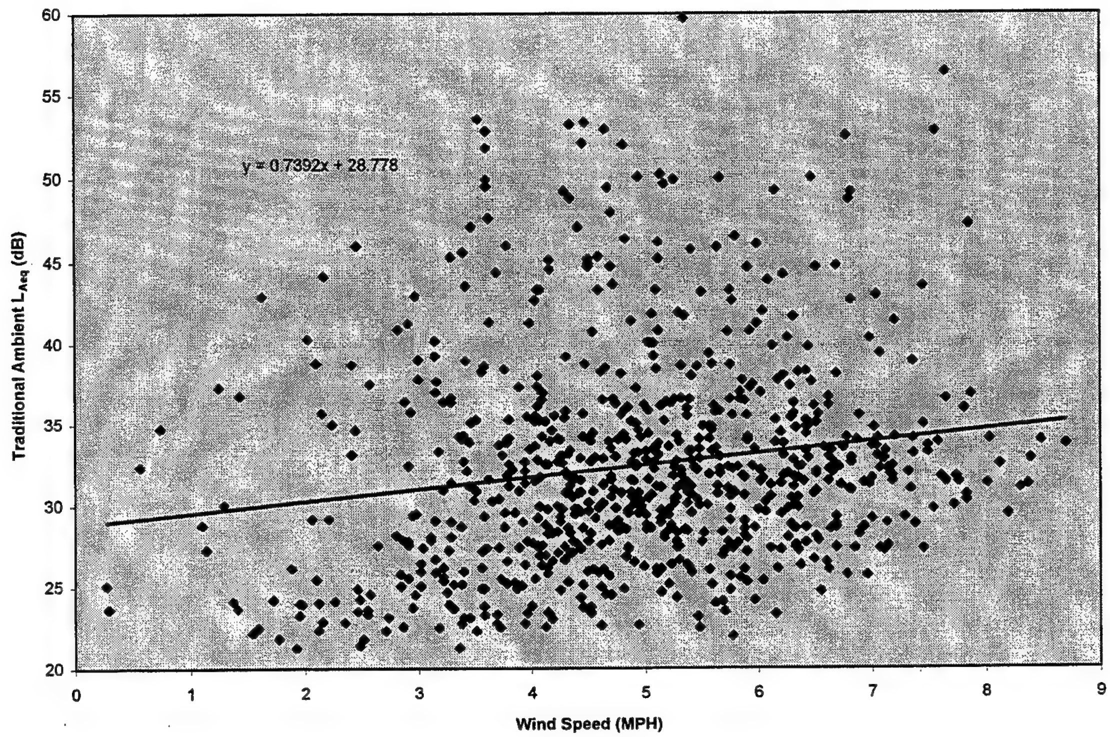


Figure 45. Traditional Ambient L_{Aeq} vs. Wind Speed: North Nest Key

6.4.10 Pavilion Key

Pavilion Key was a remote site located in the western most portion of the park. Measurements were conducted on only one occasion as follows: Thursday, August 20 from 08:07 to 11:05 (2 hours, 58 minutes).

The traditional ambient at Pavilion Key was 45.4 dB.

Pavilion Key was a heavily vegetated site, surrounded by dense mangrove. In addition, there was a strong relationship between wind speed and observed surf-on-the-beach noise at this site (see Figure

46). Consequently, the computed wind effect of 1.71 dB/mph was determined to be statistically significant (assuming a 95 percent confidence interval). In accordance with Section 6.1, the wind effect at this site was classified as Category 1.

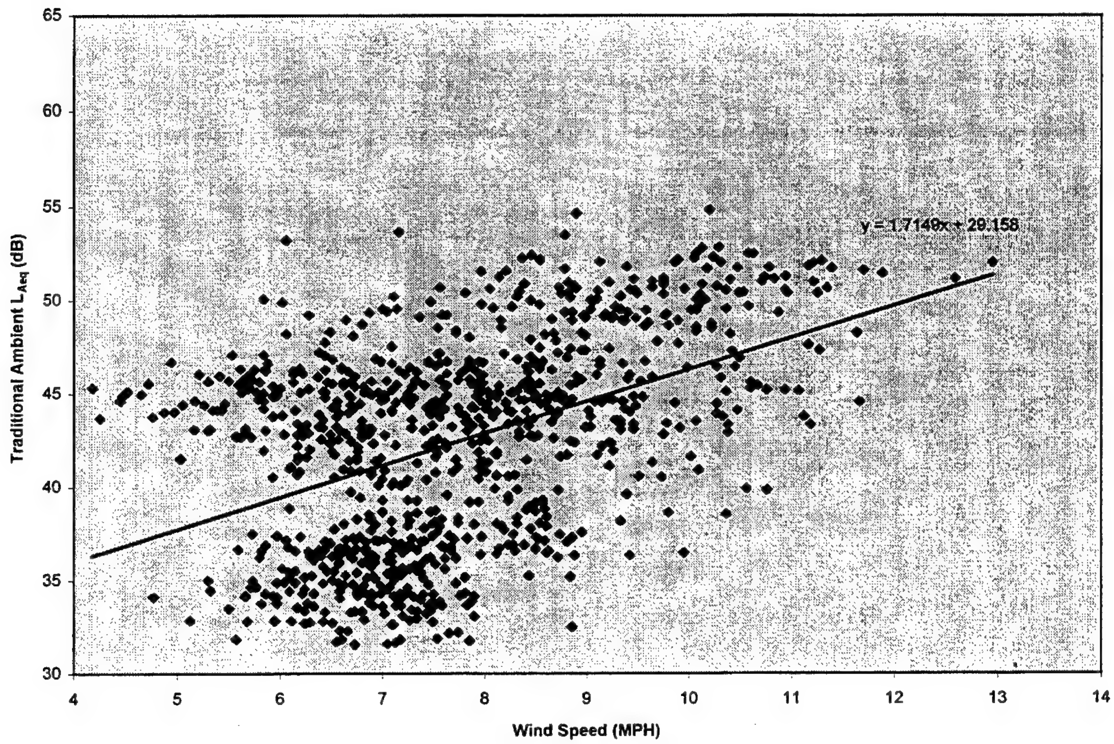


Figure 46. Traditional Ambient L_{Aeq} vs. Wind Speed: Pavilion Key

6.4.11 Pinelands

At Pinelands, measurements were made on three separate occasions as follows: (1) Wednesday, August 12 from 15:18 to 17:04 (1 hour, 46 minutes); (2) Thursday, August 13 from 07:19 to 10:20 (3 hours, 1 minute); and (3) Wednesday, August 19 from 08:48 to 11:40 (2 hours, 52 minutes). Weekday measurements were conducted so as to represent a substantial portion of the daylight hours, i.e., those hours when park visitation was expected to be at its peak.

As can be seen from the summary data, the traditional ambient sound level was somewhat inconsistent for the three separate measurement periods (41.6 dB on August 12 versus 45.2 dB on August 13 versus 49.8 dB on August 19). It is interesting to note that in the morning hours at this site, (before about 11:00) the measured ambient was dominated by the sounds of insects. This is most readily apparent by comparing the traditional ambient and the natural ambient. The natural is actually slightly higher than the traditional; and the majority of the natural sounds were observed in the morning. This can also be seen in Figure 47, which shows the traditional ambient on an hour-by-hour basis. This helps to explain the variability in the measured ambient from time period to time period. Data from the three periods were averaged as discussed in Section 5.3; and the resultant traditional ambient at Pinelands was 47.1 dB.

Although Pinelands was a heavily vegetated site, the observed wind speeds were so low that the wind effect was determined to be not statistically significant (assuming a 95 percent confidence interval). In accordance with Section 6.1, the wind effect at this site was classified as a Category 2 (see Figure 48).

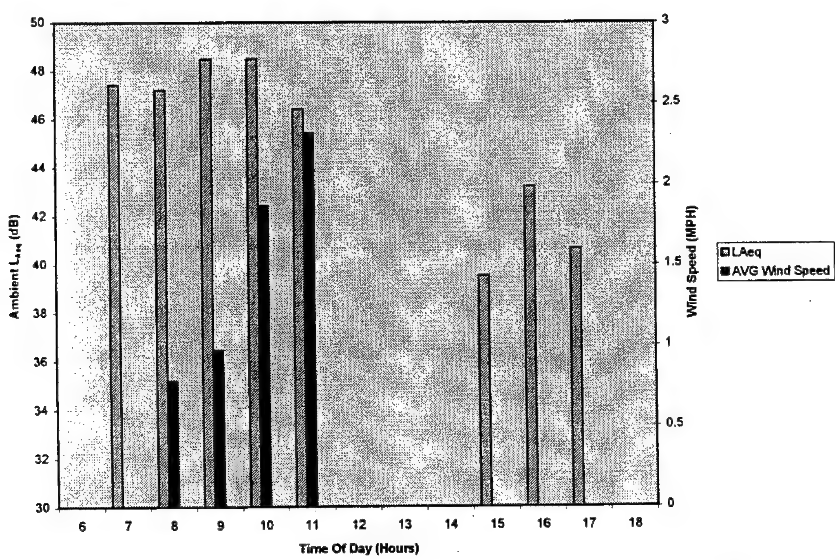


Figure 47. Variability in Traditional Ambient on an Hour-to-Hour Basis at Pinelands

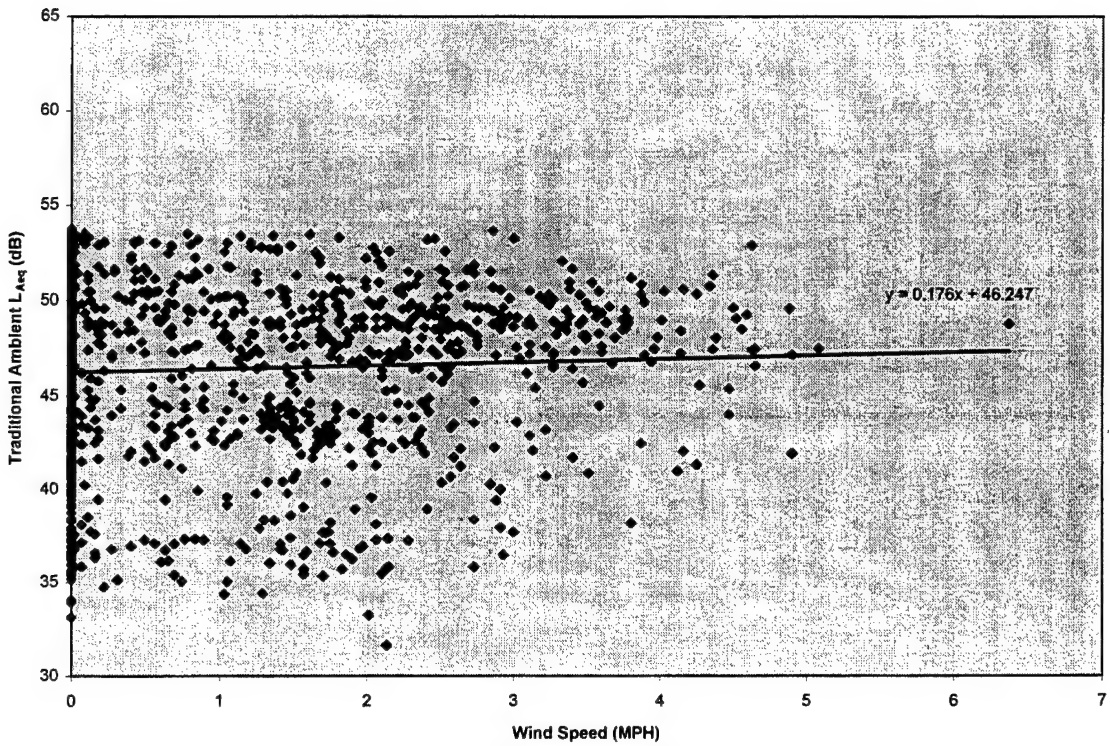


Figure 48. Traditional Ambient L_{Aeq} vs. Wind Speed: Pinelands

6.4.12 Shark Valley

At Shark Valley measurements were made on two separate occasions as follows: (1) Thursday, August 13 from 09:26 to 12:29 (3 hours, 3 minutes); and (2) Sunday, August 16 from 08:05 to 11:03 (2 hours, 58 minutes). Because Shark Valley is one of the more popular visitor locations in ENP, measurements were conducted on the weekend when visitor volume was expected to be at its peak. The specific time-of-day selected for weekend measurements was chosen so as to overlap with the time-of-day associated with one of the weekday measurements. By doing so a so-called "weekend offset" could be most easily quantified.

As can be seen, a 7 dB increase in the traditional ambient was measured on the weekend (49.1 versus 42.1 dB). This increase can be directly attributed to the increased visitor volume (both visitors on foot and visitors and researchers in airboats). In fact, the percentage of time visitors and airboats were audible increased from 38.8 percent during the week to 52.2 percent on the weekend. In addition, the average wind speed was 1.3 mph higher on the weekend, also possibly contributing to the increased sound level. Data from the two periods were averaged as discussed in Section 5.3; and the resultant traditional ambient at Shark Valley was 45.7 dB.

Shark Valley was a heavily vegetated site, surrounded by dense saw grass. Consequently, the computed wind effect of 1.46 dB/mph was determined to be statistically significant (assuming a 95 percent confidence interval). However, this may or may not be misleading because the majority of data were measured at wind speeds below 5 mph (see Figure 49). In accordance with Section 6.1, the wind effect at this site was classified as Category 2.

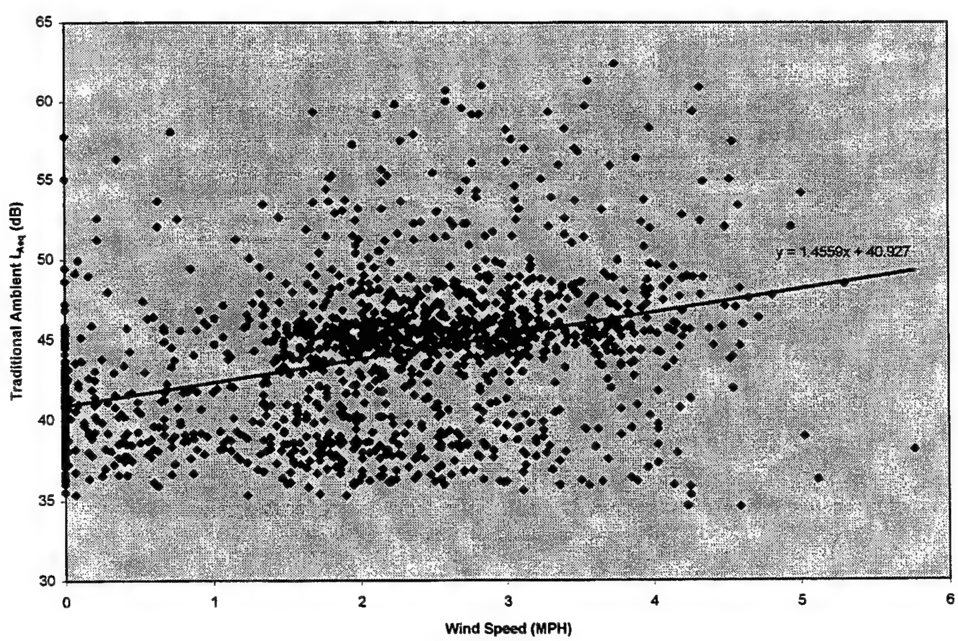


Figure 49. Traditional Ambient L_{Aeq} vs. Wind Speed: Shark Valley

6.4.13 Whitewater Bay

Whitewater Bay was an extremely remote water-based site where measurements were only conducted on one occasion as follows: (1) Monday, August 17 from 11:12 to 14:08 (2 hours, 56 minutes).

The traditional ambient at Whitewater Bay was 42.0 dB.

Whitewater Bay was a water-based site at which a direct relationship between wind speed and wave-on-the-hull noise was observed. Consequently, the computed wind effect of 0.77 dB/mph was determined to be statistically significant (assuming a 95 percent confidence interval). In accordance with Section 6.1, the wind effect at this site was classified as Category 1 (see Figure 50).

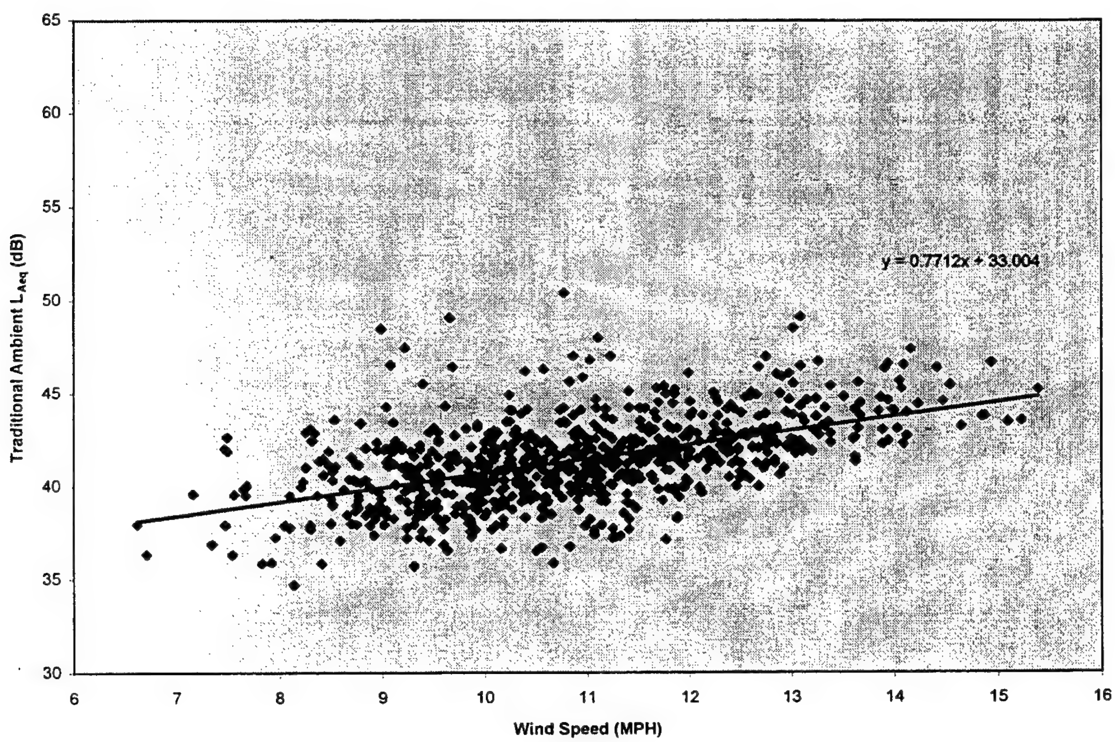


Figure 50. Traditional Ambient L_{Aeq} vs. Wind Speed: Whitewater Bay

6.5 Crocodile Lake National Wildlife Refuge

This section presents a discussion of the traditional ambient sound level data measured at the three CLK sites. It is important to point out that the three measurement sites were within 3 mi. of one another. Consequently, measurements made at these sites indicated an extremely consistent sound level (within 2 dB of one another), regardless of time of day and day of week. This is of particular significance for the Barnes Sound site, which was a last minute substitute for the Crocodile Pond site (an extremely high priority site for the NPS). The consistent measurements at the three CLK sites would seem to indicate that the data would also be representative of the Crocodile Pond site, due to its close proximity to the Barnes Sound site (they were approximately 3 mi. apart). As is the case for the other three units, the sites are presented in alphabetical order.

6.5.1 Barnes Sound

At the Barnes Sound, site measurements were only conducted on one occasion as follows: Wednesday, August 19 from 12:26 to 14:14 (1 hour, 48 minutes).

The traditional ambient at Barnes Sound was 39.9 dB.

Barnes Sound was a heavily vegetated site, surrounded by dense mangrove. Consequently, the computed wind effect of 0.49 dB/mph was determined to be statistically significant (assuming a 95 percent confidence interval). In accordance with Section 6.1, the wind effect at this site was classified as Category 1 (see Figure 51).

6.5.2 Hardwood Hammock

At the Hardwood Hammock site, measurements were only conducted on one occasion as follows: Tuesday, August 18 from 10:44 to 13:39 (2 hours, 55 minutes).

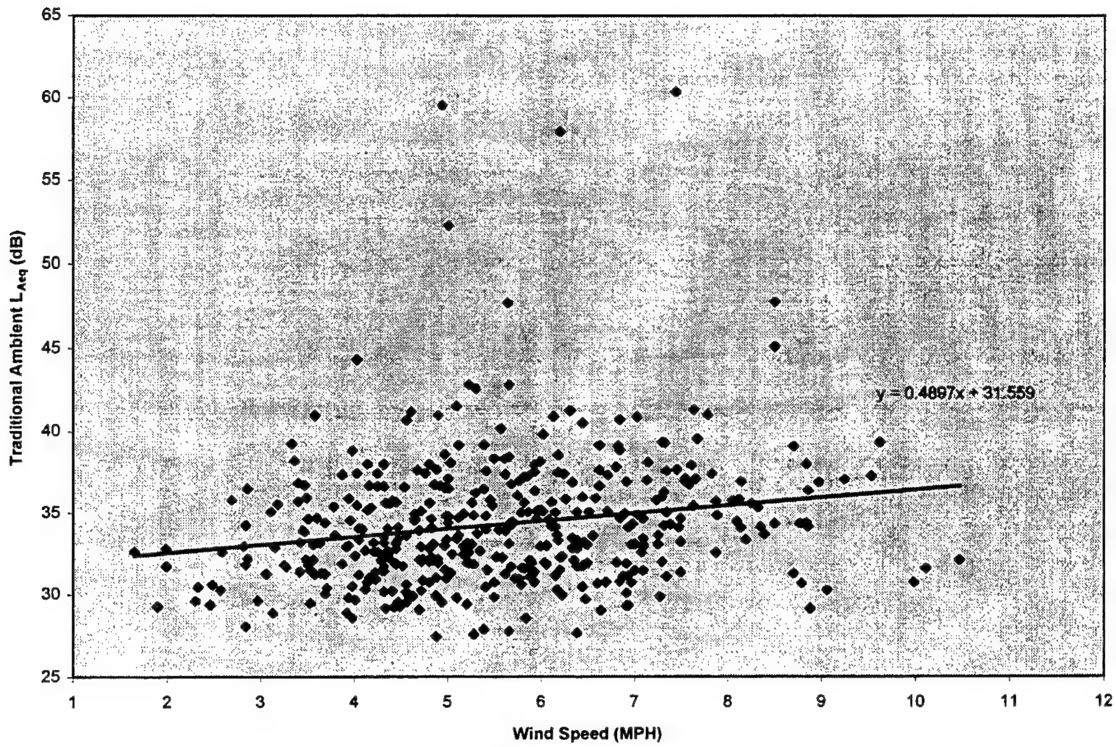


Figure 51. Traditional Ambient L_{Aeq} vs. Wind Speed: Barnes Sound

The traditional ambient at the Hardwood Hammock site was 41.3 dB.

Hardwood Hammock was a heavily vegetated site, surrounded by dense hardwoods. Consequently, the computed wind effect of 0.62 dB/mph was determined to be statistically significant (assuming a 95 percent confidence interval). In accordance with Section 6.1, the wind effect at this site was classified as Category 1 (see Figure 52).

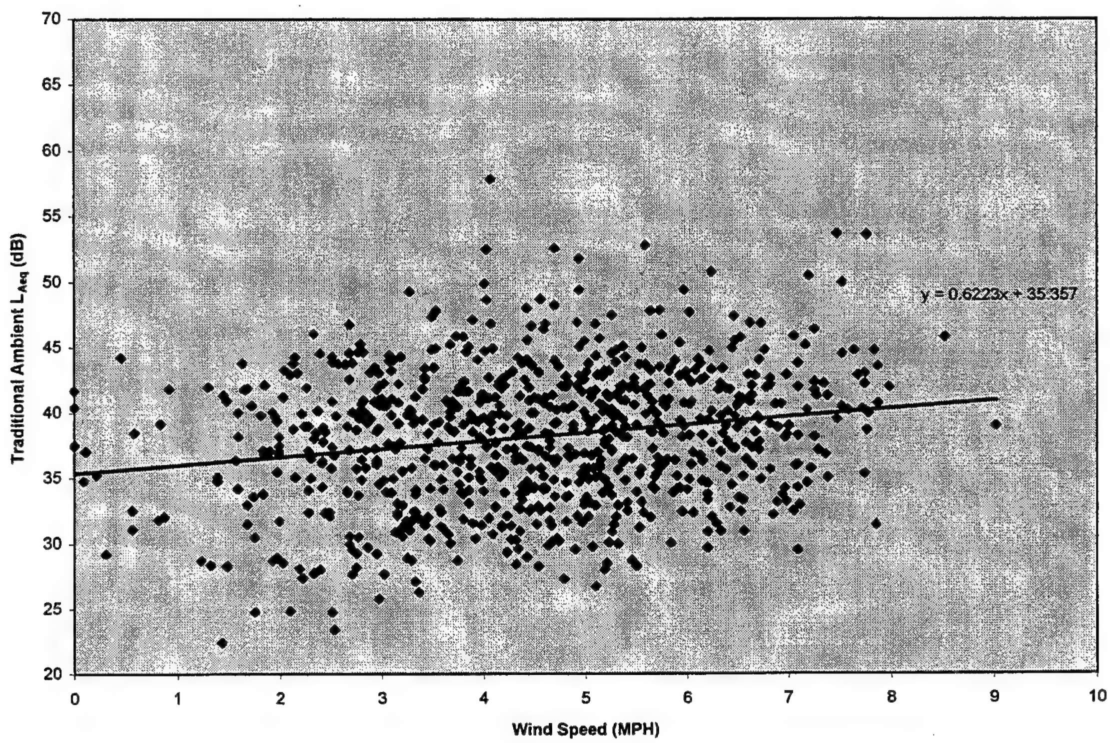


Figure 52. Traditional Ambient L_{Aeq}vs. Wind Speed: Hardwood Hammock

6.5.3 Mangrove Inlet

At Mangrove Inlet, measurements were made on two separate occasions as follows: (1) Tuesday, August 18 from 08:03 to 09:33 (1 hour, 30 minutes); and (2) Tuesday, August 18 from 14:40 to 16:10 (1 hour, 30 minutes). The measurements were conducted so as to encompass a substantial portion of the daylight hours.

As can be seen from the summary data, the traditional ambient sound level was extremely consistent for the two measurements (41.7 versus 39.6 dB, with the slightly lower value occurring during the afternoon measurements on August 18). Data from the two measurements were averaged as discussed in Section 5.3; and the resultant traditional ambient at Mangrove Inlet was 40.8 dB.

Although Mangrove Inlet was a heavily vegetated site surrounded by dense mangrove, the observed wind speeds were so low that the wind effect was determined to be not statistically significant (assuming a 95 percent confidence interval). In accordance with Section 6.1, the wind effect at this site was classified as a Category 2 (see Figure 53).

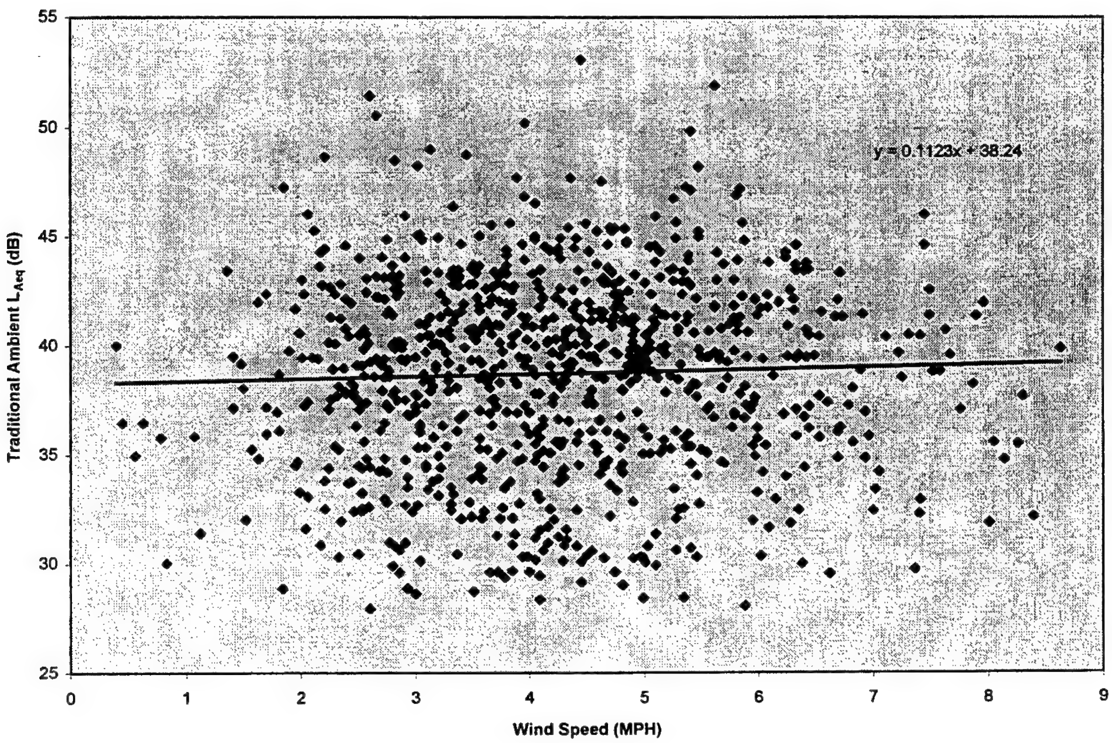


Figure 53. Traditional Ambient L_{Aeq}vs. Wind Speed: Mangrove Inlet

6.6 Big Cypress National Preserve

This section presents a discussion of the traditional ambient sound level data measured at the two BCY sites.

6.6.1 Golightly Campground

At the Golightly Campground, measurements were made on two separate occasions as follows: (1) Sunday, August 16 from 12:53 to 15:41 (2 hours, 48 minutes); and (2) Monday, August 17 from 07:59 to 10:58 (2 hours, 59 minutes). The Golightly Campground was not purposely selected as a weekend site. However, the site was located extremely close to an air boat launch ramp, and ramp activity increased substantially on the weekend. Consequently, a so-called "weekend offset" could be quantified.

As can be seen, an approximate 11 dB increase in the traditional ambient was measured on the weekend (53.6 dB versus 43.0 dB during the week). This increase can be directly attributed to the increased ramp activity. In fact, the percentage of time airboats were audible increased from 7.9 percent during the week to 41.8 percent on the weekend. In addition, the average wind speed was 0.6 mph higher on the weekend, also possibly contributing to the increased sound level. Data from the two periods were averaged as discussed in Section 5.3; and the resultant traditional ambient at Golightly Campground was 49.3 dB.

Due to low measured wind speeds at this site, the wind effect was determined to be not statistically significant (assuming a 95 percent confidence interval). In accordance with Section 6.1, the wind effect at this site was classified as Category 2 (see Figure 54).

6.6.2 National Scenic Trail

At the National Scenic Trail site, measurements were only conducted on one occasion as follows: (1) Thursday, August 20 from 08:44 to 11:21 (2 hours, 37 minutes).

The traditional ambient at the National Scenic Trail site was 43.5 dB. Unlike the majority of the other measurement sites included in the study, at the National Scenic Trail site there was a substantial

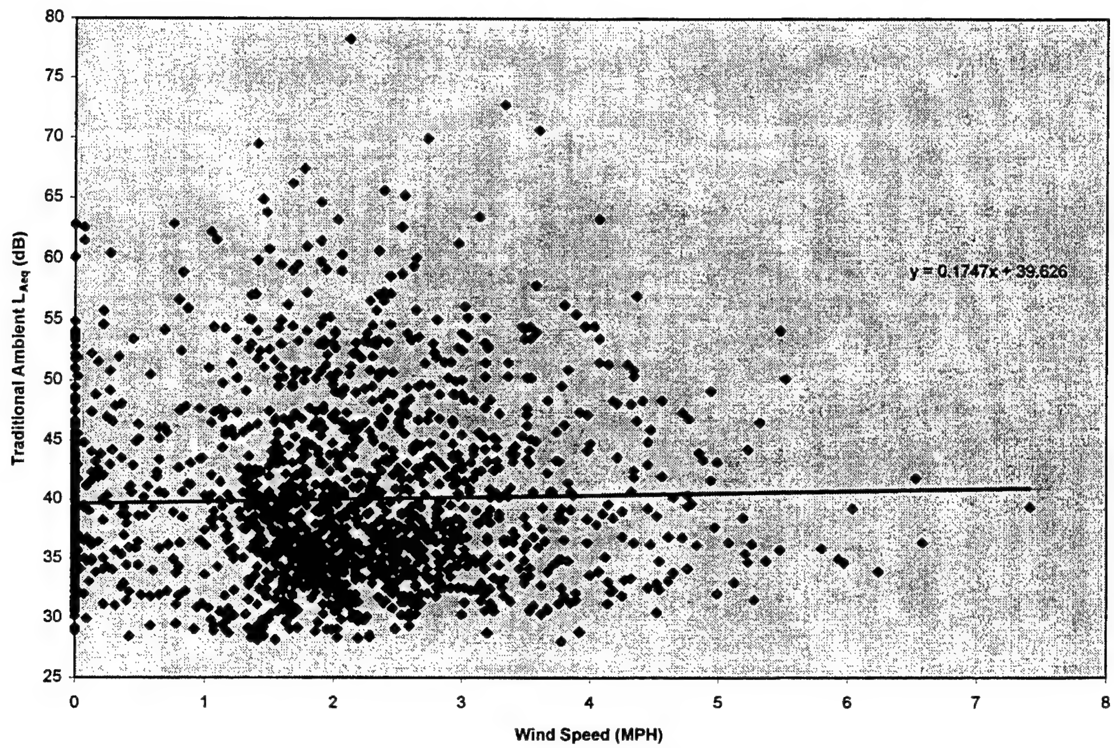


Figure 54. Traditional Ambient L_{Aeq} vs. Wind Speed: Golightly Campground

difference in the traditional ambient as compared to the existing ambient, with the traditional ambient some 14.9 dB lower in level. The reason for this difference can be attributed to the fact that this site was located extremely close to both an active airstrip, and a fairly busy roadway.

The wind effect of -0.85 dB/mph at the National Scenic Trail site was determined to be statistically significant (assuming a 95 percent confidence interval). This may be misleading, however, due to the masking effect of other noise sources in the area, namely non-aircraft sources related to airstrip activity. In accordance with Section 6.1, the wind effect at this site was classified as Category 3 (see Figure 55).

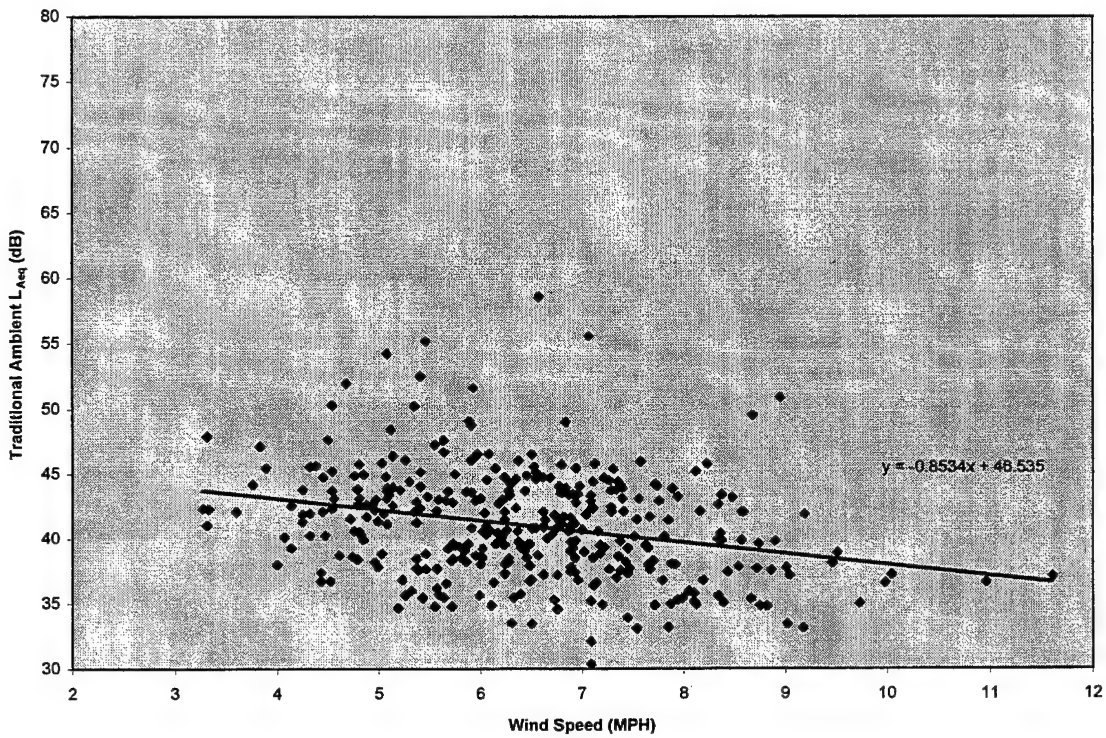


Figure 55. Traditional Ambient L_{Aeq} vs. Wind Speed: National Scenic Trail

6.7 Additional Meteorological Data

In addition to the meteorological data measured directly in support of this study, the NPS provided the research team with a year long set of meteorological data measured at six locations scattered throughout the four units. These locations are shown in Figure 56. Originally, it was anticipated that this data would be used in tandem with the wind effect data to normalize measured ambient sound levels to the equivalent of an average annual ambient sound level. It was intended that this process would be performed in accordance with the methodology presented in the Guidelines Document. However, the process of normalizing the data collected in support of this study was determined to be inappropriate for two reasons: (1) the NPS meteorological sites were far too sparse to accurately

represent the 29 ambient noise measurement sites; and (2) as discussed in Sections 6.3 through 6.6, the computed wind effect was misleading at many of the measurement sites, thus precluding the possibility of normalization. In fact, at only 15 of the 29 measurement sites was the wind effect determined to be completely reliable (Category 1). At eight of the 29 sites the range in wind speed was too small to compute a reliable wind effect (Category 2 -- average wind speeds less than 5 mph). For five of the sites the wind effect was considered unreliable due to contamination in the measured data due to some localized noise source (Category 3). At one of the sites the computed wind effect was somewhat unique and could not be categorized.

However, the NPS meteorological data is useful in at least one regard. Specifically, Table 6 presents, by month, a summary of the NPS measured wind speed data. For reference, the lowest monthly wind speeds are highlighted. As can be seen, wind speeds are generally at their lowest level, or close to their lowest, during the month of August, when the current measurements were conducted. This is an important observation, since ambient sound level generally increases with increasing wind speed. It is therefore a logical conclusion that the ambient sound levels measured during this study are likely lower than those that would be measured for the so-called average annual day. In other words, the measured ambient sound levels are probably lower than would be measured at any other time of the year. Further, any ambient-based analysis performed using this data could be considered conservative from the standpoint of impact analysis.

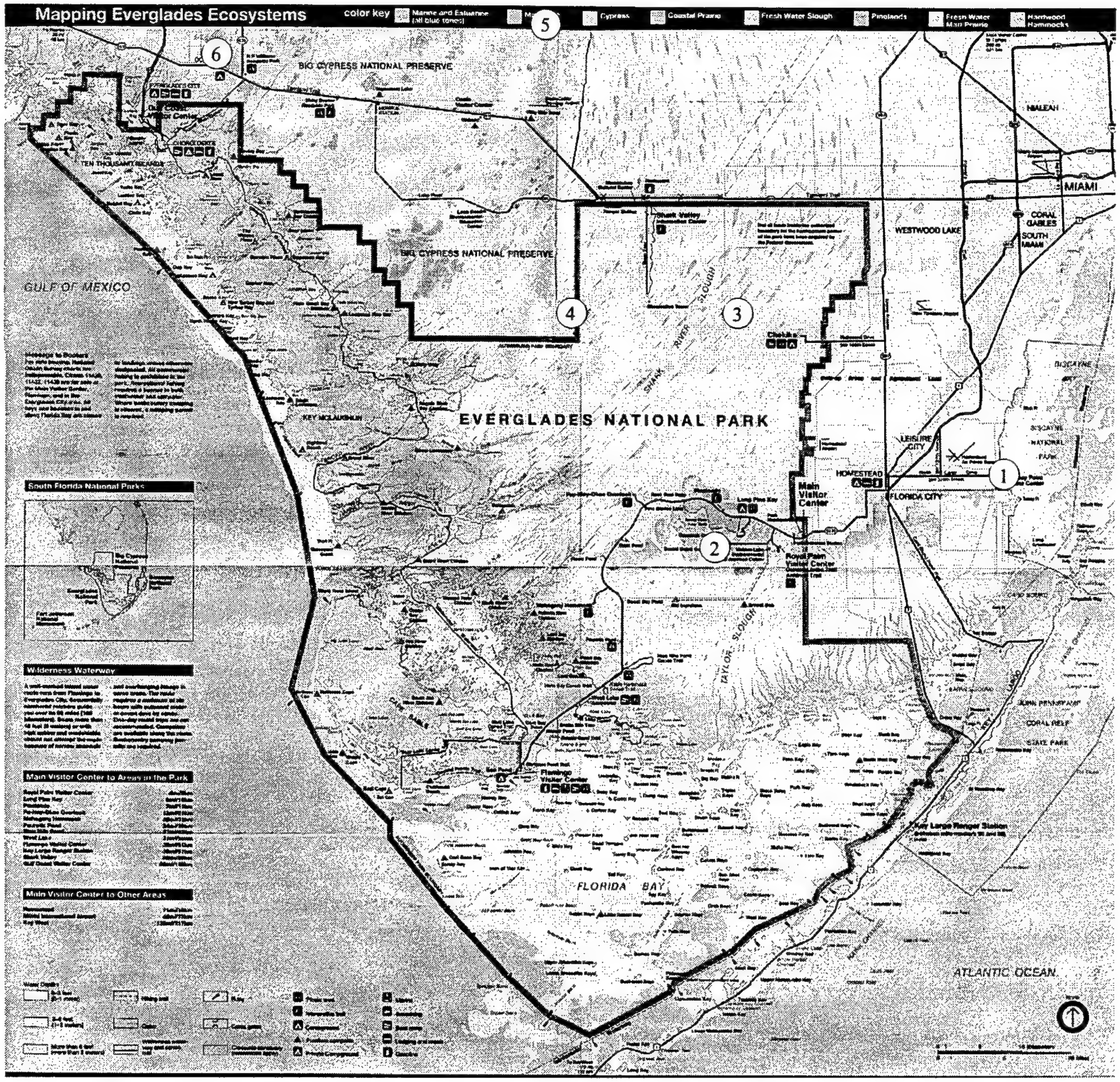


Figure 56. Location of NPS Meteorological Stations

Table 6. Summary of NPS Wind Speed Data

Month	NPS Meteorological Measurement Sites (See Figure 56)					
	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6
July 1997	9.2	5.4	8.3	7.4	2.6	4.4
August 1997	8.2	4.6	6.5	5.4	2.4	4.3
September 1997	9.2	5.0	6.6	7.3	3.4	5.2
October 1997	11.8	5.3	9.0	9.1	4.3	5.7
November 1997	10.8	6.4	6.5	10.2	4.6	5.8
December 1997	8.9	8.6	7.4	9.6	4.0	5.9
January 1998	11.5	9.2	10.3	10.9	4.8	6.2
February 1998	12.4	10.6	12.0	12.2	5.4	7.9
March 1998	13.5	9.1	10.5	10.3	5.6	7.6
April 1998	13.2	9.5	10.8	10.2	4.4	6.6
May 1998	9.3	7.0	8.0	8.2	3.1	5.1
June 1998	8.7	6.2	7.1	7.5	2.9	4.1

6.8 Comparison with Other Data

As part of the Homestead SEIS, the NPS hired Sanchez Industrial Design Inc. (SID) to conduct ambient sound level measurements in southern Florida.[13] During the time period from September 18 through October 5, 1997, SID performed approximately 25 hours of measurements at 16 sites in BNP and ENP. As a follow-up to that study, during the time period from November 17 through 20, 1998, SID conducted an additional 6 hours of observer-based monitoring. Also, in August of 1995 the consulting firm of Post, Buckley, Schuh & Jernigan, Inc. (PBS&J) conducted ambient sound level measurements in southern Florida.[19] The PBS&J study consisted of some 10 hours of measurements at 10 sites, some of which were within the boundary of BNP and ENP. This section presents a comparison of ambient sound level data measured in the current study with those measured previously at similar sites by SID and PBS&J.

6.8.1 NPS/SID Data

NPS/SID traditional ambient measurements done in September and October of 1997 and in November of 1998 were included together with the FAA/Volpe Center's traditional ambient measurements to develop the average measured traditional ambient noise levels used in the Homestead SEIS, as reflected in Table 9. Table 7 presents a comparison of traditional ambient sound level data measured in the current study with those measured at 12 either identical or similar sites in the 1997/1998 NPS/SID studies. Note that for each site in Table 7, a single value is presented for the NPS/SID traditional ambient sound level; these values were arrived at using the same processing methodology presented in Section 5, including application of the 5/7 (weekday) and 2/7 (weekend) weighting factors during the logarithmic averaging process. The table is arranged by unit, with the data for BNP presented first followed by the data for ENP and the data for CLK. (NPS/SID did not perform any measurements at duplicate sites in BCY.) Within the three units, the individual measurement sites are arranged alphabetically by name. The difference in traditional ambient sound level presented in the table represents the data measured in the current study minus the NPS/SID data.

In half of the cases, the data measured at comparable sites in the two studies are similar (generally within 3 dB). There are six sites in which the differences could be considered substantial, i.e., Rubicon Key (7.9 dB), Soldier Key (9.5 dB), and the Visitor Center (7.6 dB) in BNP, and Anhinga Trail (16.4 dB), Eco Pond (6.9 dB), and Pinelands (7.4 dB) in ENP. The possible reasons for such large differences are numerous, but in most cases can likely be attributed to simple temporal variability. Temporal variability, as well as other possible sources for the differences are discussed below.

At most sites, NPS/SID did not document the latitude and longitude of their precise measurement location. There is potentially some minor cause for concern here, since it is possible that some localized noise source could have been represented in one set of data that wasn't included in the other.

Unfortunately, the lack of documented position in the case of the NPS/SID study precludes further investigation. It is unlikely that different measurement locations were a concern for the water-based sites (Featherbed Bank, Pacific Reef, Rubicon Key and North Nest Key), since by definition they will not be in the vicinity of a localized noise source, other than maybe a few transient boats; but it may be of minor concern for comparable land-based sites (Anhinga Trail, Biscayne Visitor Center, Boca Chita, Eco Pond, Elliott Key, Fender Point, Pinelands and Soldier Key).

Table 7. Comparison of FAA and Previous NPS Measurement Data

Measurement Site	FAA/Volpe Traditional Ambient (dB)	NPS/SID Traditional Ambient (dB)	Difference (dB)
Biscayne National Park (BNP)			
Boca Chita	48.6	50.3	-1.7
Elliott Key	49.3	45.6	3.7
Featherbed Bank*	48.8	51.3	-2.5
Pacific Reef**	50.6	53.2	-2.6
Rubicon Key	50.6	42.7	7.9
Soldier Key	58.7	49.4	9.3
Visitor Center	57.4	49.8	7.6
Everglades National Park (ENP)			
Anhinga Trail	55.4	38.8	16.6
Eco Pond	48.3	41.2	7.2
North Nest Key	39.8	41.0	-1.2
Pinelands***	47.1	39.7	7.4
Crocodile Lake National Wildlife Refuge (CLK)			
Barnes Sound	39.9	38.5	1.4

* The traditional ambient sound level measured at Featherbed Bank in the current study is compared with that measured by NPS/SID at their "Bay - Central to East" site. Based on the coordinates provided in Reference 13 for the "Bay" site (25 28 40.7N; 80 14 51.4W), it is located approximately 1.7 mi from the Featherbed Bank site included in the current study.

** The traditional ambient sound level measured at Pacific Reef in the current study is compared with that measured by NPS/SID at the "Reef off Caesar Creek" site. Reference 13 does not include a precise latitude and longitude for the "Caesar Creek" site, but maps included in this reference show the site to be just to the west of the Pacific Reef site included in the current study.

*** The traditional ambient sound level measured at Pinelands in the current study is compared with that measured by NPS/SID at the "Long Pine Key" site. Reference 13 does not include a precise latitude and longitude for the "Long Pine Key" site, but maps included in this reference show the site to be extremely close in proximity to the Pinelands site included in the current study.

Note: (1) Comparisons were not made between data taken at the Fender Point site in both studies, because the site was a land-based site in the current study, and a water-based site in the NPS/SID study; (2) Comparisons were not made between data taken at the National Scenic Trail site in both studies, because the two measurement points were approximately 2.4 mi distant from one another.

In addition, NPS/SID employed the NPS LONOMS system during their measurements.[14] The LONOMS system has built into it a somewhat arbitrary ***spike smoothing*** algorithm. This algorithm eliminates impulsive sounds such as bird chirps, insects, or possibly even some mechanical sounds. Obviously, elimination of such sounds will bias the measured data towards a lower value, as compared with not invoking the algorithm. It is important to point out that SID has begun examination of this issue for the NPS, and preliminary indications are that the bias is typically only on the order of a few tenths of a decibel, and almost always less than one decibel.

The most likely source of differences between the traditional ambient sound levels measured in the current study and comparable levels measured in the NPS/SID study are simple temporal variations. In other words, these differences can be attributed to such non-quantifiable variables as time-of-year and time-of-day. Figure 47 in Section 6.4.11 illustrates the concern associated with time-of-day as well as day-to-day variability. Presented in this figure is the traditional ambient sound level on an hour-to-hour basis measured over a three-day time period in the current study at the Pinelands site in ENP. Measurements made in the morning from 0700 to 1100 are relatively consistent hour-to-hour, with maximum variations of about 2 dB. In the afternoon from 1500 to 1700, the maximum variations increase to about 4 dB. Considering both the morning and afternoon measurements together, variations of as large as 9 dB are observed from hour to hour.

To further illustrate this point, Figure 57 presents the hour-to-hour variability in the traditional ambient sound level measured in the current study at the Eco Pond site in ENP. Keep in mind that these data were measured in the same day. As can be seen, the hour-to-hour variation within a given day is as large as 4 dB. As was the case at the Pinelands site, much of this variability at Eco Pond can be attributed to the sounds of insects and birds. The hour-to-hour variability at Soldier Key (figure not shown), another site whose ambient sound level was dominated by insects, was as large as 9 dB.

Also, it is important to keep in mind that the NPS/SID measurements generally took place over a one hour time period at a given site, whereas in the current study measurement durations at a particular site were typically either three or six hours. This difference in measurement duration, coupled with the hour-to-hour variability presented in example Figures 47 and 57 are the most likely explanation for the differences in traditional ambient sound level measured in the current study as compared with that measured in the NPS/SID studies. This is ***not*** to say that one data set is of higher quality than the other, but rather care must be taken in comparing the two data sets because simple temporal variations may lead to potentially inappropriate comparisons and as such possible confusion.

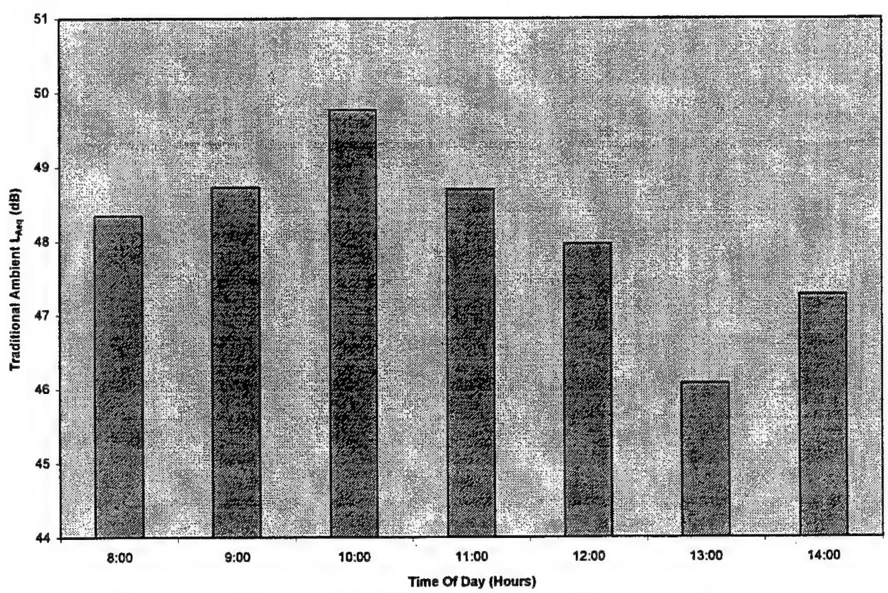


Figure 57. Variability in Traditional Ambient on an Hour-to-Hour Basis at Eco Pond

6.8.2 PBS&J Data

Table 8 presents a comparison of ***existing*** ambient sound level data measured in the current study with those measured at three either identical or similar sites in the 1995 PBS&J study. The table is arranged by unit, with the data for BNP presented first followed by the data for ENP. (PBS&J did

not perform any measurements in either CLK or BCY.) It is important to emphasize that the comparison presented herein is for the existing ambient sound level (***including aircraft***). Unfortunately, the PBS&J data were not collected in such a way so as to allow comparison of the traditional ambient.

As can be seen, at two of the three sites (Black Point and Anhinga Trail) the existing sound level was relatively similar, i.e., differences of between 2 and 3 dB. However, at the third site, the Biscayne Visitor Center, the measurements made in the current study were substantially higher in level (13.5 dB). The reason for such a large difference can be attributed to the substantial increase in human activity for measurements made on August 11 in the current study (see Section 6.3.11). In fact, a direct comparison of the PBS&J existing ambient and the existing ambient measured at the BNP Visitor Center on August 16 (when visitor activity was considered to be more typical) indicates fairly good agreement (46 dB for the PBS&J data versus 49.9 dB in the current study, a difference of just 3.9 dB).

Table 8. Comparison of FAA and Previous PBS&J Measurement Data

Measurement Site	FAA/Volpe Existing Ambient (dB)	PBS&J Existing Ambient (dB)	Difference (dB)
Black Point (BNP)	54.6	52	2.6
Visitor Center (BNP)	59.5 / 49.9	46	13.5 / 3.9
Anhinga Trail (ENP)	53.0	50	3.0

6.9 Traditional Ambient Sound Level Maps

As stated in Section 1.1, the primary objective of this study was to accurately characterize the ambient sound level environment *throughout*: (1) BNP; (2) ENP; (3) CLK; and (4) the southern portion of BCY.* The research team determined that the best approach to achieve this objective was to develop a comprehensive grid of ambient sound levels (i.e., an ambient *map*) for each unit. The map would be developed using the *traditional* ambient sound level data obtained in both the current study and the two NPS/SID studies as a baseline; and generalizing this baseline data to regularly-spaced grid points throughout each unit. In total, the 29 measurement sites represented in the current study (12 of which were also duplicated in the NPS/SID study), and the 8 additional unique sites represented in the NPS/SID studies made up the baseline data. With the exception of the Fender Point site, at the 12 sites where measurements were conducted in the current study as well as by NPS/SID, the resultant data were combined in accordance with the methodologies outlined in Section 5. The NPS/SID data measured at Fender Point were not used because the site was a land-based site in the current study, and a water-based site in the NPS/SID study;

Section 6.9.1 overviews the required input to the ambient mapping process. Section 6.9.2, 6.9.3, and 6.9.4 describe the process used to develop the ambient map for BNP, ENP and CLK, respectively. Section 6.9.5 discusses the reasons why a similar ambient map for Big Cypress National Preserve (BCY) was not technically appropriate. Section 6.9.6 overviews the general form of the output of the ambient mapping process, while Section 6.9.7 describes how this output data is used as input to the INM. Figures 58 through 60 present the traditional ambient sound level maps for ENP, BNP and CLK, respectively. Figure 61 presents a graphic displaying the *traditional* ambient data obtained at the five measurement sites in BCY.

* Upon initiation of the ambient mapping process, the research team determined that development of a comprehensive map for BCY was not technically appropriate and would introduce an unacceptable level of error due to the fact that measurements were only conducted at five measurement sites within this expansive unit.

6.9.1 Inputs to Ambient Mapping Process

The ambient maps were generated using three main sources of data: (1) unit boundaries provided by the NPS; (2) land-cover data provided by the Florida Game and Fresh Water Fish Commission (FGFWFC); and (3) traditional ambient sound levels obtained at the 29 measurement sites represented in the current study (including similar data from the 12 NPS/SID duplicate sites), as well as data from the eight additional unique sites represented in the NPS/SID studies. These three data sets were input to a Volpe Center computer program entitled AMBIGRD.

Table 9 lists, by unit, the 37 sites where sound level measurements were conducted. This table includes the latitude and longitude of the site (WGS-84 reference), the land-cover type assigned to the site based on the FGFWFC data, the traditional ambient sound level measured at the site (current and NPS/SID combined where appropriate), and a text description of the FGFWFC land-cover type. It should be noted that equivalent sound levels representing longer durations dominate the result when averaging multiple values. In the case of Table 9, the current data was typically of longer duration than the NPS/SID data, and thus the final average sound levels tend to be closer to the current values. In addition, the land cover assigned to each site was checked for reasonableness against: (1) observations recorded on the field data log sheets; and (2) site photographs. The original land cover assignment at eleven sites (Black Point, Pacific Reef, Soldier Key, Stiltsville and the Visitor Center, in BNP; Hidden Lake, North Nest Key, and Broad River Campground, in ENP; and Halfway Creek, Bear Island, and National Scenic Trail, in BCY) was changed based on the reasonableness check. The details of these changes are also summarized in Table 9.

The data in Table 9 consistently indicate that the traditional ambient sound levels measured at sites classified as open water tended to be slightly higher than those measured at land-based sites in the same geographic proximity. Consequently, regardless of unit, when assigning ambient sound levels to land-based areas, only data measured at land-based sites were used. Similarly, when assigning ambient sound levels to water-based areas, only data measured at water-based sites were used. This dichotomy is reflected in Table 10, which amongst other things summarizes the land cover categories represented within each unit (This table is discussed in further detail in Section 6.9.3 for ENP). Depending upon the specific unit, the above three sources of data were used differently in developing the respective ambient sound level maps. The methodology used for each unit is described in detail in subsequent sections.

Table 9. Summary of FGFWFC Land-Cover Categories and Traditional Ambient Sound Level Data for Each Measurement Site

Site Name	Site ID	Latitude	Longitude	Original FGFWFC Type Code	Traditional Ambient (dB)	Original FGFWFC Land-Cover Category
Biscayne National Park (BNP)						
Black Point	A	25 31 47 N	80 17 57 W	0	51.8	Background(1)
Boca Chita	C/SID	25 31 28 N	80 10 33 W	19	49.0	Grassland (Agriculture)
Elliott Key	I/SID	25 27 14 N	80 11 45 W	9	48.6	Tropical Hardwood Hammock
Featherbed Bank	P/SID	25 30 01 N	80 14 16 W	18	49.6	Open Water
Fender Point	F	25 28 11 N	80 20 26 W	16	47.3	Mangrove Swamp
Mangrove Key	H	25 24 17 N	80 18 54 W	18	45.1	Open Water
Pacific Reef	E/SID	25 22 03 N	80 08 54 W	0	51.6	Background(1)
Rubicon Key	D/SID	25 23 31 N	80 14 01 W	18	49.8	Open Water
Soldier Key	L/SID	25 35 28 N	80 09 39 W	0	56.2	Background(2)
Stiltsville	J	25 37 17 N	80 08 57 W	0	54.9	Background(1)
Visitor Center	G/SID	25 27 52 N	80 20 05 W	18	56.2	Open Water(3)
Everglades National Park (ENP)						
Anhinga Trail	B/SID	25 23 01 N	80 36 22 W	19	54.2	Grassland (Agriculture)
Buchanan Key	Y	24 54 58 N	80 46 29 W	18	45.8	Open Water
Chekika	O	25 36 45 N	80 35 04 W	8	41.0	Hardwood Hammocks and Forests
East. Panhandle	M	25 17 16 N	80 26 30 W	22	54.9	Barren and Urban
East. Sparrow	V	25 29 52 N	80 39 45 W	11	31.2	Freshwater Marsh and Wet Prairie
Eco Pond	Q/SID	25 08 19 N	80 56 16 W	16	47.2	Mangrove Swamp
Hidden Lake	R	25 22 55 N	80 37 06 W	11	36.0	Freshwater Marsh and Wet Prairie(4)
Little Madeira Bay	U	25 11 45 N	80 37 42 W	18	46.7	Open Water
North Nest Key	X/SID	25 09 06 N	80 30 41 W	10	39.9	Coastal Salt Marsh(5)
Pavilion Key	AA	25 42 31 N	81 21 03 W	18	45.4	Open Water(6)
Pinelands	K/SID	25 25 22 N	80 40 47 W	3	46.5	Pineland
Shark Valley	N	25 39 23 N	80 45 59 W	15	45.7	Scrub Swamp
Whitewater Bay	T	25 14 48 N	80 57 51 W	18	42.0	Open Water
Broad River Cmp	SID1	25 28 51 N	81 08 19 W	18	46.2	Open Water(7)
Pay-hay-okee	SID2	25 26 35 N	80 47 01 W	11	39.7	Freshwater Marsh and Wet Prairie

Site Name	Site ID	Latitude	Longitude	Original FGFWFC Type Code	Traditional Ambient (dB)	Original FGFWFC Land-Cover Category
Nine-Mile Pond	SID3	25 15 19 N	80 47 52 W	16	44.6	Mangrove Swamp
Carl Ross Key	SID4	25 02 40 N	81 01 11 W	18	43.2	Open Water(6)
Canepatch Cmp	SID5	25 25 19 N	80 56 38 W	8	39.0	Hardwood Hammocks and Forests
Crocodile Lake National Wildlife Preserve (CLK)						
Barnes Sound	AD/SID	25 14 29 N	80 20 03 W	16	39.2	Mangrove Swamp
Hardwood Hammock	W	25 15 56 N	80 18 39 W	9	41.3	Tropical Hardwood Hammock
Mangrove Inlet	AC	25 13 36 N	80 20 01 W	9	40.8	Tropical Hardwood Hammock
Big Cypress National Preserve (BCY)						
Golightly Campground	S	25 45 17 N	80 55 35 W	12	49.3	Cypress Swamp
National Scenic Trail	AE	25 51 47 N	81 02 06 W	11	43.5	Freshwater Marsh and Wet Prairie
Halfway Creek	SID6	25 52 28 N	81 21 28 W	10	64.0	Coastal Salt Marsh(8)
Bear Island	SID7	26 12 56 N	81 18 01W	13	33.7	Hardwood Swamp(9)
National Scenic Trail	SID8	26 13 04 N	81 04 25 W	19	34.1	Grassland (Agriculture)(10)

(1) The Background category (which is pertinent only in BNP) corresponds to measurement sites which were beyond the area covered by the FGFWFC file (i.e., there was no land-cover data in the file). In these three instances the sites were reassigned to Open Water (18), based on data recorded on the field data log sheets.

(2) The Background category (which is pertinent only in BNP) corresponds to measurement sites which were beyond the area covered by the FGFWFC file. In this instance the site was reassigned to Coastal Strand (1), based on data recorded on the field data log sheets.

(3) Based on the discussion presented in Section 6.8.2, this site was reassigned to Barren and Urban (22).

(4) Based on data recorded on the field data log sheets this site was reassigned to Hardwood Hammocks and Forests (8).

(5) Based on data recorded on the field data log sheets this site was reassigned to Barren and Urban (22).

(6) Although these two sites were land-based sites, their proximity to the shore resulted in the ambient sound level being dominated by surf noise; therefore the original FGFWFC Open Water (18) assignment was deemed appropriate.

(7) Based on a 1/4/99 telecommunication with SID this site was reassigned to Tropical Hardwood Hammock (9).

(8) Based on a 1/4/99 telecommunication with SID this site was reassigned to Mangrove Swamp (16).

(9) Based on a 1/4/99 telecommunication with SID this site was reassigned to Hardwood Hammocks and Forests (8).

(10) Based on a 1/4/99 telecommunication with SID this site was reassigned to Cypress Swamp (12).

Table 10. Mapping of Land-Cover Categories for Everglades National Park (ENP)

General Class	Original FGFWFC Type Code(1)	Original FGFWFC Land-Cover Category	Mapped FGFWFC Type Code
Land-Based (Acoustically Soft)	3	Pineland (1)(2)	3
	7	Mixed Hardwood-Pine Forests	3
	8	Hardwood Hammocks and Forests (3)(2)	8
	9	Tropical Hardwood Hammock (1)(2)	8
	20	Shrub and Brushland	8
	21	Exotic Plant Communities	19
	19	Grasslands (Agriculture) (1)(2)	19
	2	Dry Prairie	19
	1	Coastal Strand	22
	22	Barren and Urban (2)(2)	22
Water-Based (Acoustically Hard)	12	Cypress Swamp	15
	13	Hardwood Swamp	15
	15	Scrub Swamp (1)(2)	15
	16	Mangrove Swamp (2)(2)	16
	11	Freshwater Marsh and Wet Prairie (2)(2)	11
	10	Coastal Salt Marsh(2)	11
	18	Open Water (5)(2)	18
No Data	0	Background (3)	18

(1) From FGFWFC file.

(2) Number in parentheses coincides with number of measurement sites represented by a particular land-cover type code.

(3) The Background category corresponds to areas which were beyond that covered by the FGFWFC file (i.e., there was no land-cover data in the file). In ENP all of these areas were located in the Open Water.

6.9.2 Biscayne National Park (BNP)

In general, assignment of ambient sound levels to areas in BNP was based on proximity to the geographically closest acoustically soft or acoustically hard measurement site. That is to say, the data from each water-based measurement site was assigned to the closest open water areas, and the data from each land-based measurement site was assigned to the closest land areas. In line with this general rule, the following is noted:

1. The land-based area on the western shore of Biscayne Bay between the Visitor Center site and Turkey Point (located about 2 mi. to the south of the Center) was assigned the traditional ambient sound level measured at the Visitor Center. Similarly, the ambient sound level measured at the Visitor Center site was also assigned to the western shore of Biscayne Bay, for the area north of the Center, halfway between the Center site and the Fender Point site. Boat traffic and other human-related activity dominate the ambient sound level in the vicinity of the Visitor Center. As such, assigning ambient sound levels to this area based on data measured in areas where there is little or no human-related activity would result in an artificially low ambient.

2. The land-based area on the western shore of Biscayne Bay, north of the halfway point between the Fender Point site and the Visitor Center site was assigned the traditional ambient sound level measured at the Fender Point site.

3. With the exception of the extreme southern portion of the BNP keys, areas on these islands east of the Intra-Coastal Waterway were assigned the ambient sound level measured at either

Boca Chita Key, Elliott Key, or Soldier Key depending upon geographical proximity.*

Two important exceptions to the above general rule were, however, deemed appropriate:

1. Measured ambient sound level data from CLK were used for mapping land-based locations in the southern-most land areas of BNP. This exception was only implemented in the southwestern corner and southernmost portion of the keys in BNP. Because conditions in the southern portion of BNP more closely resemble conditions at CLK (rather than conditions at Boca Chita, Elliott Key, Fender Point, Soldier Key or the Visitor Center -- the other BNP land-based measurement sites), ambient sound levels for the land-based areas in this part of BNP were based on the measured sound level obtained at the hardwood hammock site in CLK (even though some BNP measurement sites were geographically closer). Note, because of the wide disparity in human-related activity, no measured ambient data from ENP or BCY were used for mapping in BNP.

2. The water-based area in the immediate vicinity of the Visitor Center extending south down to Turkey Point was assigned the ambient sound level associated with the Black Point site rather than the Mangrove Key site, which was actually geographically closer. This was considered a more appropriate assignment because the observed boat activity in the vicinity of the Center more closely resembled such activity around the Black Point site as compared to the Mangrove Key site, where there was virtually no boat activity.

* Special measurements were performed in the current study to determine the decrease in sound level as a function of distance from the primary measurement location at both the Elliott Key and the Boca Chita Key site. At each site, a second sound level meter (SLM) was placed 500 ft away from the primary measurement location. The secondary SLM was placed at a point as far as possible away from human activity. At Boca Chita the sound level measured by the secondary SLM was about 3 dB lower than that measured at the primary instrument. At Elliott Key the sound level measured at the secondary SLM was about 2 dB lower than that measured at the primary instrument. These relatively small differences seem to indicate that ambient conditions do not vary markedly throughout the keys, and a proximity-base approach seems reasonable for ambient assignment on these islands.

Note that in Table 9, the BNP Visitor Center site is listed as being in open water, even though it was a land-based measurement site. The reason for this apparent anomaly is that the GPS-based units used to determine site locations have an accuracy of about 300 ft. In addition, the FGFWFC land-cover maps have a resolution of slightly less than 3.5 seconds of arc (0.00095 decimal degrees) in both latitude and longitude. At the latitude of South Florida, this equates to a resolution of about 300 ft. The Visitor Center measurement site was adjacent (within 50 ft.) to Biscayne Bay. Therefore, the land-cover type for this site was considered to be Mangrove Swamp (based on the geographically closest land-based area).

In addition, the Background category reflected in Table 9 corresponds to measurement sites which were beyond the area covered by the FGFWFC file. In the case of Black Point, Pacific Reef, and Stiltsville, the sites were reassigned to Open Water, based on data recorded on the field data log sheets. In the case of Soldier Key, the site were reassigned to Coastal Strand, also based on data recorded on the field data log sheets.

6.9.3 Everglades National Park (ENP)

Past studies have shown that wind speed and ambient sound level in a backcountry environment are closely correlated. A study conducted for the NPS[9] in coniferous forests (Kiabab in Arizona, and Golden Trout in California) showed a 1.3 dB increase in ambient sound level per mile per hour increase in wind speed. A similar study conducted in Bryce Canyon National Park for the FAA[6] showed a 1.9 dB increase in the *traditional* ambient sound level per mile per hour increase in wind speed. This correlation between land-cover, ambient sound level, and wind speed is further supported by the NPS NODSS computer program which categorizes the wind effect on ambient sound level in Grand Canyon National Park based solely on land-cover type.[10]

The present study also examined the wind effect on ambient sound level. Because the study area encompassed physically unique and geographically disperse measurement sites, no single value for wind effect at all sites is applicable. In general, different sites have different wind effect values. This is discussed in further detail in Sections 6.3 through 6.6.

Given that wind speed is known to affect ambient sound level in a backcountry environment, and that different land-cover types result in differing wind effects, ambient sound level maps based on land-cover type appear to be a reasonable way of characterizing the ambient throughout a (primarily backcountry) unit, so long as localized human-made noise sources (e.g. roadways, boating corridors, power generators, etc.) do not substantially influence the measured sound levels.

The process of generating ambient maps from land-cover data and ambient sound level measurements assumes that land-cover types within a given geographic region have the same ambient characteristics. For example, if ambient levels are recorded in an area of "Hardwood Hammocks and Forests," then all Hardwood Hammocks and Forests within the area closest to the measurement site are assumed to have the same ambient levels. Hardwood Hammocks and Forests which are geographically closer to a different measurement site (but with the same land-cover classification) are assigned the ambient sound level measured at this different site. Implicit in this approach is the assumption that the wind effect dominates the ambient sound level in all Hardwood Hammocks and Forests in a given area.

In summary, knowing the land-cover type at the measurement sites where the ambient levels were obtained, and also having the land-cover type data throughout the study area, the same ambient levels were inferred to exist at sites with the same land-cover type. The following modifications were added to this inference:

1. Those land-cover types not represented by measurements were mapped to similar land-cover types for which measurements were conducted. This mapping of the original, un-represented land-cover type to represented land-cover type is summarized in Table 10. This table is arranged into an anticipated acoustical hierarchy, i.e., within a specific "General Class," the table is arranged from top to bottom based on the expected magnitude of the wind effect -- which is assumed to coincide with vegetative density. The mapping assignment was based on the assumption that similar land-cover types have similar ambient characteristics, i.e., mapping was performed in accordance with the acoustical hierarchy. For example, areas of physically low ground cover (e.g., shrubs or grass) were mapped to similar areas of low ground cover; and areas of physically high ground cover (e.g., trees) were mapped to similar areas of high ground cover. Note that land-cover types represented by measurement sites have the same original and mapped land-cover type code in Table 10. For these areas, the number of different measurement locations represented by the particular type is given in parenthesis following the type description. For example, measurements were made at one site with a land-cover type of Pineland. From Table 9, this site can be seen to be Pinelands.

2. Ambient sound levels measured at the Anhinga Trail, Eastern Panhandle, and Shark Valley sites were restricted to an area within approximately 1000 ft. (305 m) of the respective measurement site, regardless of surrounding land cover. Further, the ambient sound level measured at the Eastern Panhandle site was not assigned to other locations in ENP; and a derivative ambient sound level measured at the Anhinga Trail and Shark Valley sites was used

for assignment to other areas in ENP. More specifically, the weekday ambient sound level measured at Anhinga Trail (in the current study only) and Shark Valley (40.8 dB and 42.1 dB, respectively) were used for assignment to other areas of the park. The reason for such a unique approach (i.e., restricting the generalization of ambient sound levels measured at certain sites) at these three sites was due to the fact that during certain portions of the measurements these sites were dominated by localized vehicle or other human-related activity which was truly unique to the site.

6.9.4 Crocodile Lake National Wildlife Refuge (CLK)

The ambient sound levels measured at the three sites in CLK were within 2.1 dB. This close agreement seems to indicate a consistent ambient environment throughout the unit. For land areas in CLK, data from the geographically closest land-based measurement site were used for mapping purposes. For water areas, the measured sound level from Mangrove Key in BNP was used. Mangrove Key was the water-based site geographically closest to CLK, and with the least human-related activity.

6.9.5 Big Cypress National Preserve (BCY)

Measurements were conducted at only five sites in BCY. Less measurement work was done at BCY because of its greater distance from Homestead than the other three conservation units, resulting in higher altitudes of Homestead-related aircraft over BCY which would translate into lower aircraft noise levels. The two sites included in the current study were located in areas of substantial human activity, and as such were probably not representative of the large areas of remote property encompassed by the preserve. The Golightly Campground was located next to an airboat launching ramp which had substantial activity, especially on the weekend (see Section 6.6.1). The National Scenic Trail site was located on an active airstrip, adjacent to the only highway running through the preserve. This effectively only leaves the three NPS/SID sites in BCY for potential ambient mapping. The research team determined that the small amount of data measured at these three sites (about 3

hours total) was inadequate to develop accurate ambient maps for all of BCY. Figure 61 presents a graphic displaying the *traditional* ambient data obtained at the five measurement sites in BCY.

6.9.6 Outputs of Ambient Mapping Process

The output of the ambient mapping process is a file called [PARK]AMBIENT.GRD, which is unique to each unit. This file contains the grid of traditional ambient sound levels at the same resolution (approximately 100 meters) as the original FGFWFC land-cover files. The file is defined by: (1) the latitude and longitude of the southwest corner of the smallest rectangular grid which contains the unit; and (2) the known regular spacing of the grid points. Within this rectangular grid, areas outside of each unit's boundary are set to a value of 99, indicating that no data exists. Data in the file are preserved to the nearest whole decibel value. Preserving finer resolution (e.g., to the nearest 0.1 dB) was considered an unrealistic representation of accuracy.

The ambient grid file is then processed through a geographic information system (GIS) to generate a color map of the traditional ambient sound level within each unit. This color map is displayed in Figures 58 through 60 for BNP, ENP, and CLK, respectively. Also displayed is the coastline as defined by the National Oceanic and Atmospheric Administration (NOAA), the unit boundary as defined by NPS, major streets as defined by the U.S. Census Bureau's Tiger/Line data, as well as the measurement sites (denoted by the Site ID from Table 9).

6.9.7 Use with the INM

The [PARK]AMBIENT.GRD output file is intended to be used in conjunction with a Volpe Center-developed computer program entitled AMBIENT. Provided with the latitude and longitude of potential noise-sensitive locations in an input file, AMBIENT will use the [PARK]AMBIENT.GRD file to determine the traditional ambient sound level at each of these locations.

The [PARK]AMBIENT.GRD file may also be used directly by the INM for time-above (TA) ambient grid computations. Specifically, with this file located in the INM case directory, and with the TA descriptor selected in INM for grid point computations, the program will determine the ambient sound level at each grid point and use this value as the time-above threshold associated with computation of the TA descriptor. INM users are also given the ability to convert the TA values to percent TA for a user-defined time period, e.g., 720 minutes. To invoke this option the user must simply include an ASCII text file in the case directory which contains the normalizing time period, expressed in minutes. This file should be named PERCENT.DAT.

Appendix D overviews all of the enhancements made to INM in support of this study.

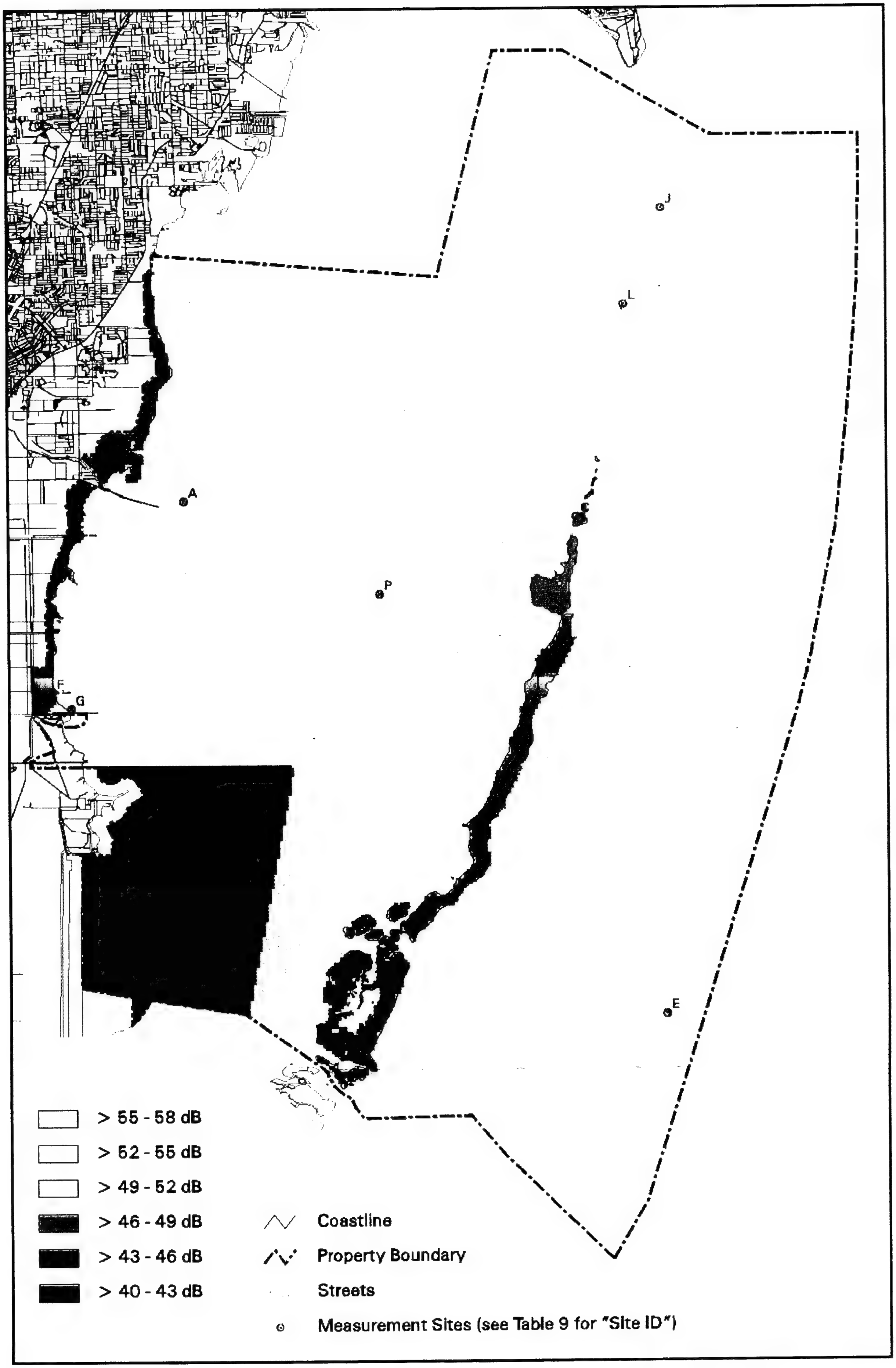


Figure 58. Traditional Ambient Sound Level Map for Biscayne National Park (BNP)

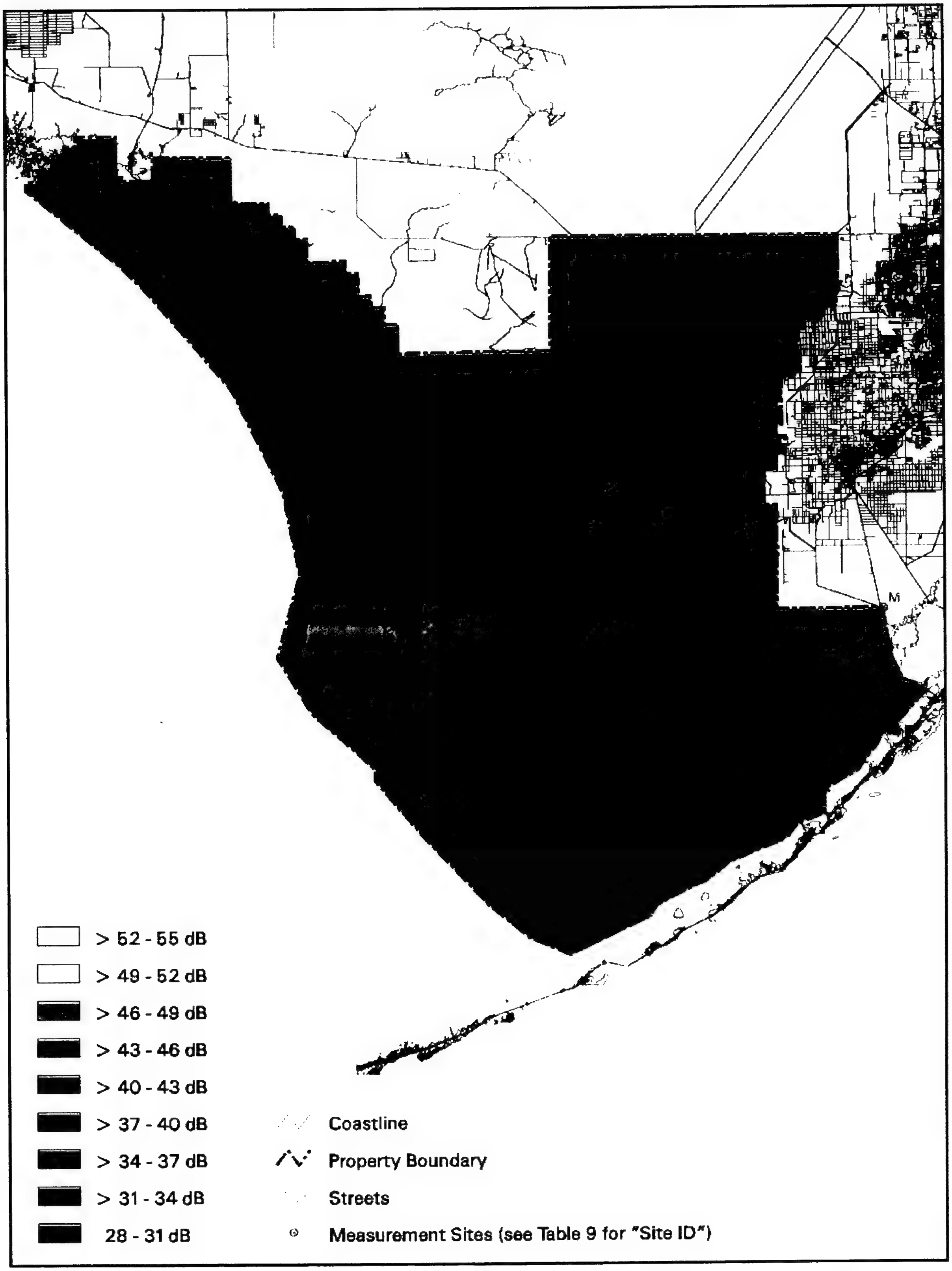


Figure 59. Traditional Ambient Sound Level Map for Everglades National Park (ENP)

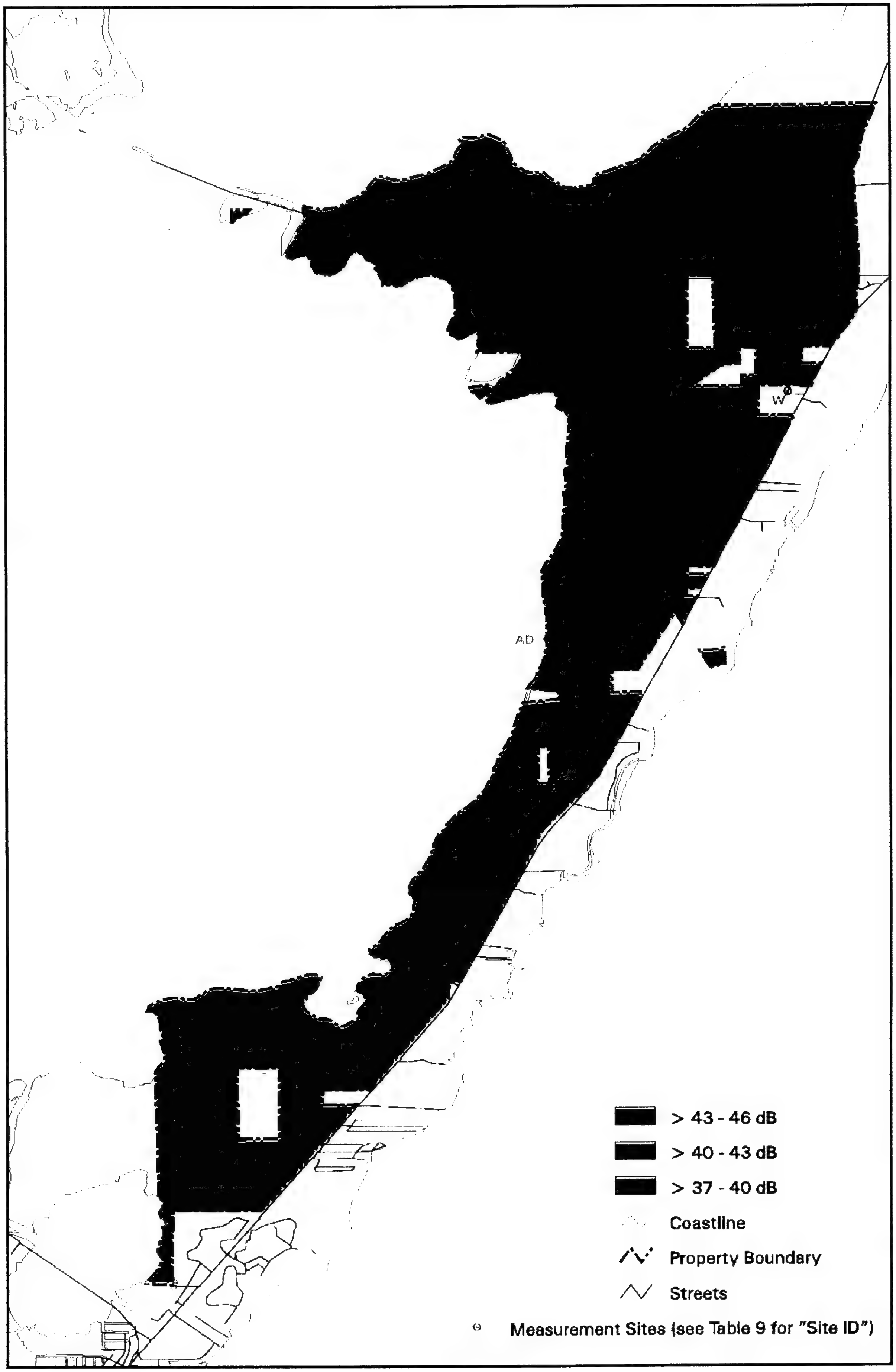


Figure 60. Traditional Ambient Sound Level Map for Crocodile Lake National Wildlife Refuge (CLK)

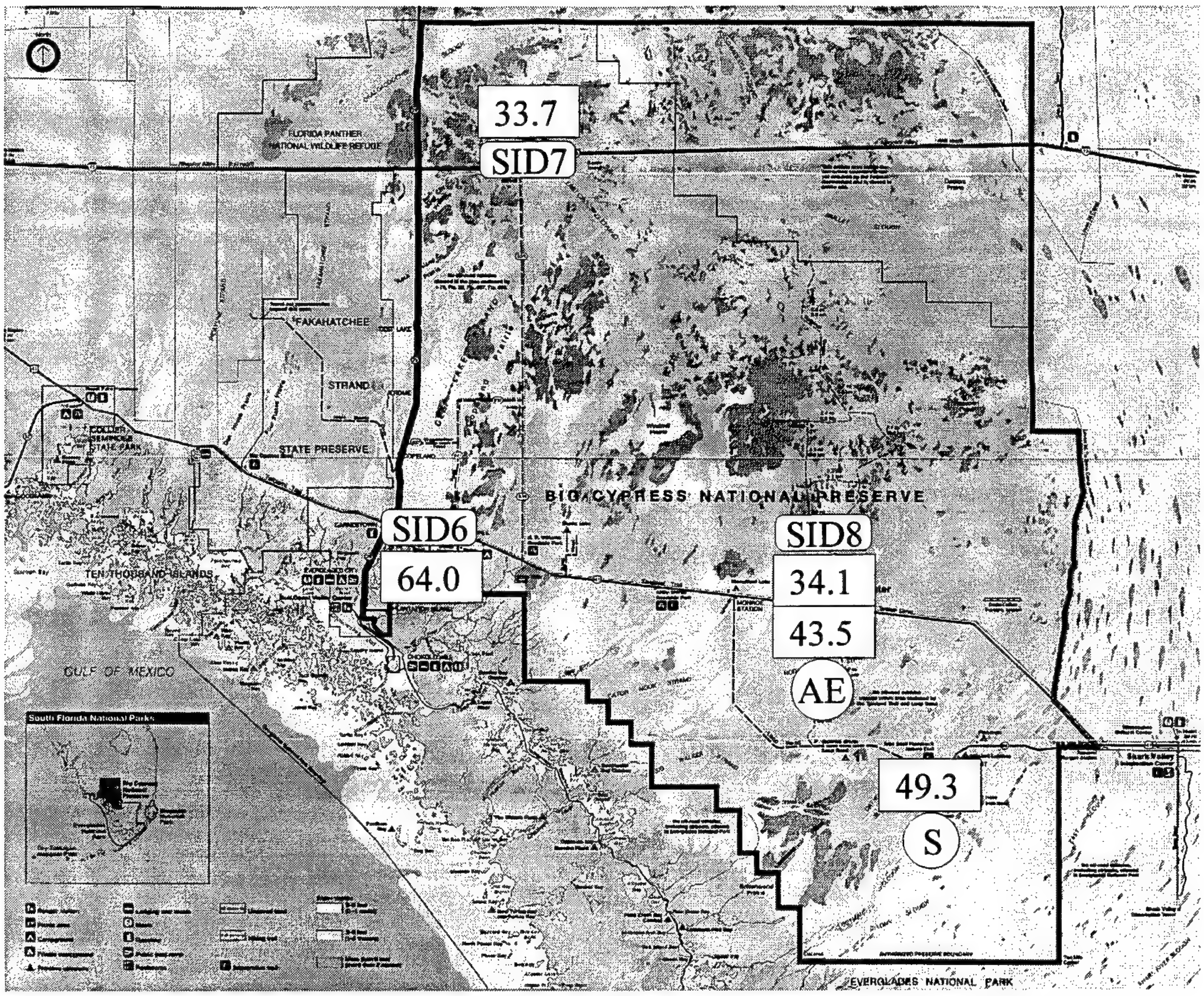


Figure 61. Traditional Ambient Sound Levels at Big Cypress National Preserve (BCY)

7. References

1 "Acoustical Terminology," American National Standard, ANSI S1.1-1994, New York: American National Standards Institute, 1994.

2 "Procedures for Outdoor Measurement of Sound Pressure Level," American National Standard, ANSI Standard S12.18-1994, New York: American National Standards Institute, 1994.

3 Johnson, Dan L., Marsh, Alan H., and Harris, Cyril M, "Acoustical Measurement Instruments," Handbook of Acoustical Measurements and Noise Control, New York: Columbia University, 1991.

4 Federal Interagency Committee on Aviation Noise (FICAN), "Report on Aviation Noise Research Conducted by U.S. Federal Agencies," Burlington, MA: Harris Miller Miller & Hanson Inc, June 1994.

5 Fleming, Gregg G., Roof, Christopher J., Read, David R., "Draft Guidelines for the Measurement and Assessment of Low-Level Ambient Noise," Cambridge, MA: John A. Volpe National Transportation Systems Center Acoustics Facility, March 1998.

6 Fleming, Gregg G., et. al., "Development of Noise Dose/Visitor Response Relationships for National Park Overflight Rule: Bryce Canyon National Park Study," Cambridge, MA: John A. Volpe National Transportation Systems Center Acoustics Facility, July 1998.

7 Fleming, Gregg G., et. al., "Development of Noise Dose/Visitor Response Relationships for National Park Overflight Rule: Bryce and Grand Canyon National Park Study," Cambridge, MA: John A. Volpe National Transportation Systems Center Acoustics Facility, to be published.

8 "Crocodile Lake National Wildlife Refuge: Promotional Brochure," Key Largo, FL: U.S. Fish & Wildlife Service, 1997.

9 Sneddon, Mathew, Silvati, Laura, Pearsons, Karl S., Fidell, Sanford, Measurements and Analyses of the Indigenous Sound Environment of Coniferous Forests, Canoga Park, CA: BBN Systems and Technologies, January 1994.

10 Reddingius, Nick H., User's Manual for the National Park Service Overflight Decision Support System, Canoga Park, CA: BBN Systems and Technologies, May 1994.

11 Naeser, Robert, Science Application Information Corporation, Private transmittal of data, July 1998.

12 Welch, R., Remillard, M., Doren, R.F., "GIS Database Development for South Florida's National Parks and Preserves," Photogrammetric Engineering & Remote Sensing, Vol. 61, No. 11, pp. 1371-1381, November 1995.

13 Sanchez, Gonzalo, Acoustic Data from Biscayne National Park and Everglades National Park, Madison, WI: Sanchez Industrial Design, October 1997.

14 Miller, Nicholas P., Thompson, Richard H., Holey, George B., True, Joseph A., LOWNOMS User's Manual, Burlington, MA: Harris Miller Miller & Hanson Inc., February 1997.

15 "Specification for Sound Level Meters," American National Standard, ANSI Standard S1.4-1983 (R1990), New York: American National Standards Institute, 1990.

16 Anderson, Grant S., et. al., Dose-Response Relationships Derived From Data Collected at Grand Canyon, Haleakala and Hawaii Volcanoes National Parks, NPOA Report No. 93-6, Denver, CO: National Park Service, October 1993.

17 Miller, Nicholas P., Anderson, Grant S., Horonjeff, Richard D., Mitigating the Effects of Military Aircraft Overflights on Recreational Users of Parks: Study Design, Burlington, MA: Harris Miller Miller & Hanson Inc., May 1997.

18 Report on Effects of Aircraft Overflights on the National Park System, Washington, D.C.: National Park Service, July 1995.

19 Hertz, R., Post, Buckley Schuh & Jernigan, Inc., Private transmittal of data, August 1995.

20 Society of Automotive Engineers, Committee A-21, Aircraft Noise, Prediction Method for Lateral Attenuation of Airplane Noise During Takeoff and Landing, Aerospace Information Report No. 1751, Warrendale, PA: Society of Automotive Engineers, Inc., March 1981.

21 Olmstead, Jeffrey R., et.al., Integrated Noise Model (INM) Version 5.1 User's Guide, Report No. FAA-AEE-96-02, Washington, D.C.: Federal Aviation Administration, December 1996.

22 Fleming, Gregg G., et.al., Integrated Noise Model (INM) Version 5.1 Technical Manual, Report No. FAA-AEE-97-04, Washington, D.C.: Federal Aviation Administration, December 1997.

23 Plotkin, Kenneth J., Bradley, Kevin A., Hobbs, Christopher, "Examination of the Lateral Attenuation of Aircraft Noise," Presentation to SAE Committee A-21 in Toulouse France, October 1998.

24 Fleming, Gregg G., Senzig, David A., Clarke, John-Paul, "Aircraft Noise Prediction Model Support", John A. Volpe National Transportation Systems Center Acoustics Facility Reimbursable Agreement with NASA Langley Research Center, July 1998.

25 Fleming, Gregg G., Rapoza, Amanda S., Burstein, Joseph, Senzig, David A., "Updated Lateral Attenuation for INM," Presentation to SAE Committee A-21 in Toulouse France, October 1998.

26 Bishop, Dwight E., Beckman, Jane M., Bucka, Mike P., Revision of Civil Aircraft Noise Data for the Integrated Noise Model (INM), Report 6039, Canoga Park, CA: BBN Laboratories Incorporated, September 1986.

27 Society of Automotive Engineers, Committee A-21, Aircraft Noise, Procedure for the Computation of Airplane Noise in the Vicinity of Airports, Aerospace Information Report No. 1845, Warrendale, PA: Society of Automotive Engineers, Inc., March 1986.

28 Mohlman, Henry T., University of Dayton, Private transmittal of data, March 1998.

29 Newman, Steve, et.al., Noise Measurement Flight Test: Data/Analyses, Bell 222 Twin Jet Helicopter, FAA Report No. FAA-EE-84-1, Federal Aviation Administration: Washington, D.C., February 1984.

30 Newman, Steve, et.al., Noise Measurement Flight Test: Data/Analyses, Aerospatiale SA 365N Dauphin 2 Helicopter, FAA Report No. FAA-EE-84-2, Federal Aviation Administration: Washington, D.C., April 1984.

31 Newman, Steve, et.al., Noise Measurement Flight Test: Data/Analyses, Hughes 500 D/E Helicopter, FAA Report No. FAA-EE-84-3, Federal Aviation Administration: Washington, D.C., May 1984.

32 Newman, Steve, et.al., Noise Measurement Flight Test: Data/Analyses, Aerospatiale AS 355F Helicopter, FAA Report No. FAA-EE-84-4, Federal Aviation Administration: Washington, D.C., June 1984.

33 Newman, Steve, et.al., Noise Measurement Flight Test: Data/Analyses, Aerospatiale SA 350D Helicopter, FAA Report No. FAA-EE-84-5, Federal Aviation Administration: Washington, D.C., September 1984.

34 Newman, Steve, et.al., Noise Measurement Flight Test: Data/Analyses, Sikorsky S-76A Helicopter, FAA Report No. FAA-EE-84-6, Federal Aviation Administration: Washington, D.C., September.

35 Newman, Steve, et.al., Noise Measurement Flight Test: Data/Analyses, Boeing Vertol/CH 47-D Helicopter, FAA Report No. FAA-EE-84-7, Federal Aviation Administration: Washington, D.C., September 1984.

36 Newman, Steve, et.al., U.S. Test Report: Bell 206-L, Noise Measurement Flight Test, FAA Report No. FAA-EE-85-6, Federal Aviation Administration: Washington, D.C. September 1985.

37 Newman, Steve, et.al., Noise Levels and Flight Profiles of Eight Helicopters Using Proposed International Certification Procedures, FAA Report No. FAA-EE-79-3, Federal Aviation Administration: Washington, D.C. March 1979.

38 Newman, Steve, et.al., Helicopter Noise Definition Report, FAA Report No. FAA-EE-81-16, Federal Aviation Administration: Washington, D.C. December 1981.

39 True, et.al., Helicopter Noise Measurements, Data Report, Volumes I and II, FAA Report No. FAA-RD-77-57I & II, Federal Aviation Administration: Washington, D.C. April 1977.

40 Fleming, Gregg G., Rickley, Edward J., Heliport Noise Model (HNM) Version 2.2 User's Guide, Report No. FAA-AEE-94-01, Cambridge, MA: John A. Volpe National Transportation Systems Center Acoustics Facility, February 1994.

41 Airport Activity Statistics of Certificated Air Carriers, Washington, D.C.: U.S. Department of Transportation Statistics, Office of Airline Information, December 1995.

42 Embleton, Tony F.W., Piercy, Joe E., Daigle, Giles A., "Effective flow resistivity of ground surfaces determined by acoustical measurements," J. Acoust. Soc. Am. Vol. **74**, No. 4, pp 1239-1243, 1983.

43 Embleton, Tony, F.W., "Sound Propagation Outdoors - - Improved Prediction Schemes for the 80's," Noise Control Engineering Journal, Vol. **18**, No. 1, pp 30-39, 1982.

44 Embleton, Tony F.W., Piercy, Joe E., Daigle, Giles A., "Outdoor Sound Propagation Over Ground of Finite Impedance," J. Acoust. Soc. Am. Vol. **59**, No. 2, pp 267-277, February 1976.

45 Ingard, K.U., "A review of the influence of meteorological conditions on sound propagation," J. Acoust. Soc. Am. Vol. **25**, No. 3, pp 405-411, 1953.

46 Delaney, M.E. and Bazley, E.N., "Acoustical properties of fibrous absorbent materials," Appl. Acoust. Vol **3**, pp. 105-116, 1970.

47 Chessell, C.I., "Propagation of noise along a finite impedance boundary," J. Acoust. Soc. Am. Vol. **62**, pp 825-834, 1977.

48 De Jong, B.A., Moerkerken, A., van der Toorn, J.D., "Propagation of Sound over Grassland and over an Earth Barrier," J. Acoust. Soc. Am. Vol. **86**, No. 1, pp 23-46, 1983.

49 Engineering Science Data Unit (ESDU)· "The prediction of sound attenuation as a result of propagation close to the ground," ESDU pac A9436, London, England: ESDU, November 1994.

50 Slutsky, Simon, Bertoni, Henry L., Parallel Noise Barrier Prediction Procedure (three volumes), Cambridge, MA: Transportation Systems Center, June 1987.

51 Statistica Version 5.1 (five volumes), Tulsa, OK: StatSoft Corporation, 1995.

52 Plovsing, Birger, Aircraft Sound Propagation over Non-Flat Terrain, Prediction Algorithms, Draft Report. Lyngby, Denmark: Danish Acoustical Institute, August 1993.

53 Plotkin, Kenneth J., Moulton, Carey L., Stusnick, Eric, Feasibility of Incorporation of Terrain Effects into NOISEMAP. Technical Note TN 92-5, Arlington, VA: Wyle Laboratories, October 1992.

54 Sutherland, Louis C., Daigle, Gilles A., "Atmospheric Sound Propagation", Encyclopedia of Acoustics, Chapter 32, pp 341-365, 1997.

55 Anderson, Grant A., Lee, Cynthia S.Y., Fleming, Gregg G., Menge, Christopher W., <u>FHWA Traffic Noise Model (FHWA TNM®), Version 1.0: User's Guide</u>, Report No. FHWA-PD-96-009, Cambridge, MA: John A. Volpe National Transportation Systems Center Acoustics Facility, January 1998.

56 Menge, Christopher W., Rossano, Christopher F., Anderson, Grant A., Bajdek, Christopher J., <u>FHWA Traffic Noise Model (FHWA TNM®), Version 1.0: Technical Manual</u>, Report No. FHWA-PD-96-010, Cambridge, MA: John A. Volpe National Transportation Systems Center Acoustics Facility, February 1998.

57 Piercy, Joe E., Daigle, Giles A., "Sound Propagation in the Open Air," <u>Handbook of Acoustical Measurements and Noise Control</u>, New York: McGraw-Hill, Inc., 1991.

58 <u>Federal Aviation Regulations, Part 36, Noise Standards: Aircraft Type and Airworthiness Certification</u>, Washington, D.C.: Federal Aviation Administration, September 1992.

59 Boulanger, P., Waters-Fuller, Tim, Attenborough, Keith, Ming Li, Kai, "Models and Measurements of Sound Propagation from a Point Source over Mixed Impedance Ground," Milton Keynes, UK: Open University, 1997.

60 Plotkin, Kenneth J., Hobbs, Christopher M., Bradley, Kevin A., <u>Wyle Research Report WR 99-10, Examination of the Lateral Attenuation of Aircraft Noise, Draft Report</u>. Arlington, VA: Wyle Laboratories, April 1999.

Appendix A:
Research Team Members and Responsibilities

Federal Aviation Administration, Office of Environment and Energy:

Jake A. Plante

M.Ed., Ed.D., Education, University of Massachusetts, MA. Central point of technical contact for the FAA, Dr. Plante was responsible for FAA's day-to-day technical management of the study, including internal coordination among FAA offices and external coordination between the FAA and the NPS. Dr. Plante managed the study design, including site selection, the development of the emerging methodology for categorizing ambient sound levels, and INM development activity. INM is FAA's prediction model used to support the noise analysis in support of the Homestead SEIS.

John M. Gulding

M.S., Operations Research, George Mason University, Fairfax, VA; B.A., Mathematics, University of Virginia, Charlottesville, VA. Mr. Gulding was a member of the ambient sound level measurement team. In addition, Mr. Gulding is the Program Manager for the FAA's INM, the prediction model used to support the noise analysis for the Homestead SEIS.

Federal Aviation Administration, Office of Airport Planning and Programming:

Lynne S. Pickard

B.A., Political Science, Louisiana State University, LA; B.A., Environmental Studies, George Washington University, DC; M.A., Political Science, Georgetown University, DC. FAA Project Manager for the Homestead SEIS, Ms. Pickard was responsible for the senior management of all aspects of the study.

Ralph C. Thompson

B.S.C.E., University of Florida, FL. FAA Assistant Project Manager for the Homestead SEIS, Mr. Thompson was responsible for the senior management of all aspects of the study.

Volpe National Transportation Systems Center, Acoustics Facility:

Gregg G. Fleming

B.S., Electrical Engineering, University of Lowell, MA. Manager of the Volpe Center Acoustics Facility, Mr. Fleming participated in the study design, and site selection processes, and was in charge of all acoustics-related instrumentation, data collection, and analysis for the study. Further, Mr. Fleming was responsible for the design, testing, implementation and documentation of all INM-related enhancements performed in support of the study.

Christopher J. Roof

B.S., Electrical Engineering and Music, Boston University, MA. Mr. Roof participated in the study design, and was a member of the ambient sound level measurement team. Further, Mr. Roof coordinated data processing and analysis in support of the study.

David R. Read

Mr. Read was responsible for the development, configuration, and testing of the acoustical instrumentation, participated in the study design and site selection process, and was a member of the ambient sound level measurement team.

Joseph Burstein

Ph.D., Engineering, Odessa Institute of Technology, Odessa, Ukraine. Dr. Burstein played a lead role in the design and testing of all INM-related enhancements in support of the study.

David Senzig, P.E.

M.S., Mechanical Engineering, University of Washington, Seattle, WA. Mr. Senzig was a member of the ambient sound level measurement team. Further, Mr. Senzig assisted in data processing and analysis. Mr. Senzig also participated in the design and testing of all INM-related enhancements performed in support of the study.

Amanda Rapoza

B.S., Acoustic Engineering, University of Hartford, CT. Ms. Rapoza assisted in data processing and analysis in support of the study. Further, Ms. Rapoza participated in the design and testing of all INM-related enhancements performed in support of the study.

Paul J. Gerbi

B.S., Electrical Engineering, University of Lowell, MA. Mr. Gerbi participated in the design and testing, and was responsible for the coding of all software developed in support of this study, including all INM-related enhancements.

Cynthia S.Y. Lee

B.S., Electrical Engineering, Northeastern University, Boston, MA. Ms. Lee was a member of the ambient sound level measurement team. Further, Ms. Lee assisted in data processing and analysis in support of the study.

Lynne Osovski

B.A., Astronomy and Physics, Boston University, Boston, MA. Ms Osovski participated in the design and testing, and was responsible for the coding of many of the INM-related enhancements performed in support of the study.

Gary M. Baker

B.S., Geography, University of Massachusetts, Boston, MA. As a member of the Volpe Center Geographic Information Systems (GIS) Group, Mr. Baker helped to develop the ambient sound level and land-cover maps prepared in support of the study.

Terrapin Acoustical Services:

Kenneth D. Polcak

B.S., Civil Engineering, University of Maryland, College Park, MD. Mr. Polcak was a member of the ambient sound level measurement team.

Appendix B:
Plan View of Each Measurement Site

Site ID: A   Site Name: Black Point   Date(s): 8/10/98
8/12/98

Coordinates: 25 31 47 N / 80 17 57 W
25 32 04 N / 80 18 01 W

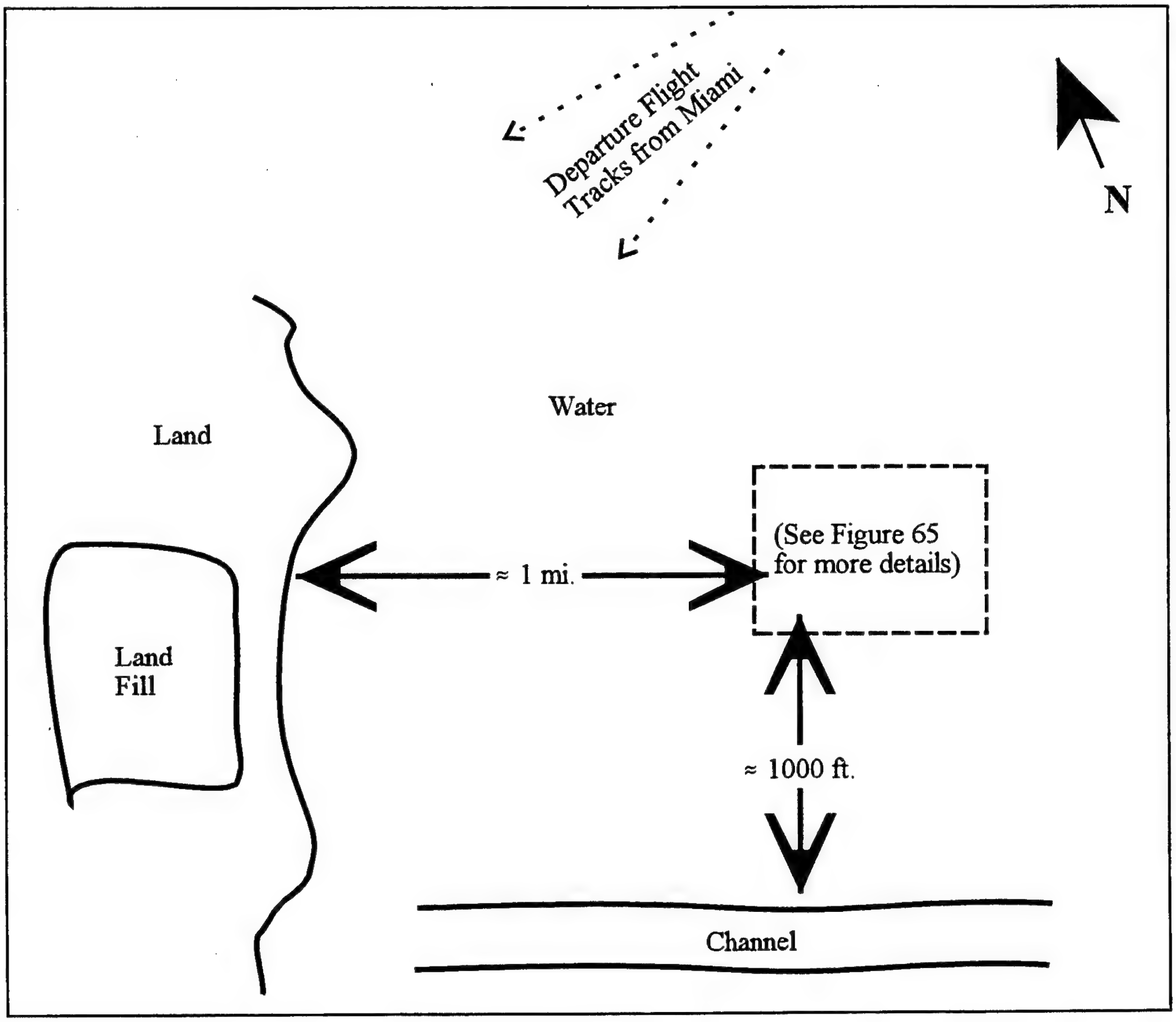


Figure 62. Plan View of Black Point Site

* Not to scale.

Site ID: C   Site Name: Boca Chita   Date(s): 8/10/98
8/13/98
8/15/98

Coordinates: 25 31 28 N / 80 10 33 W

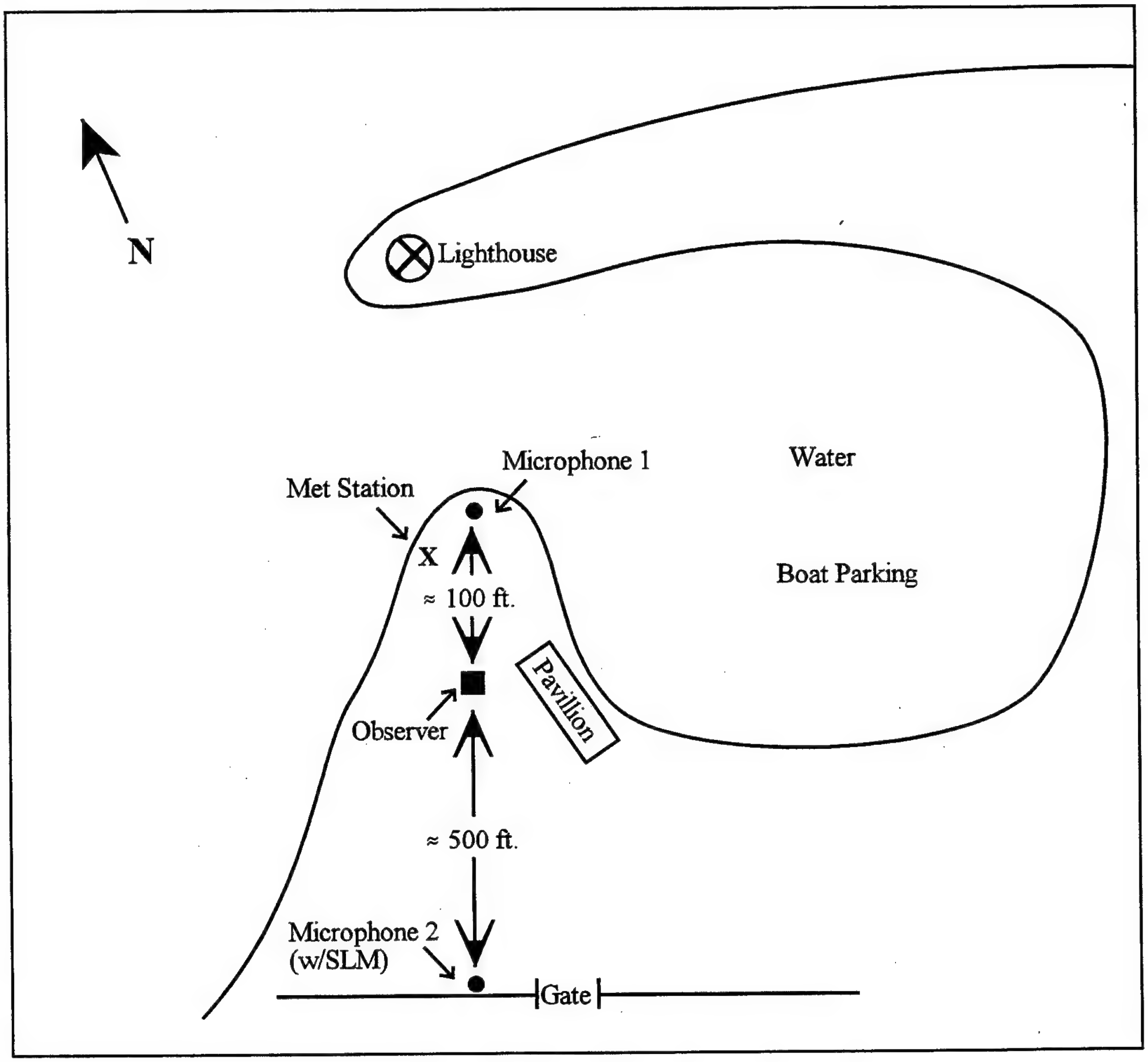


Figure 63. Plan View of Boca Chita Site

* Not to scale.

Site ID: I

Site Name: Elliott Key

Date(s): 8/12/98
8/15/98
8/17/98

Coordinates: 25 27 14 N / 80 11 45 W

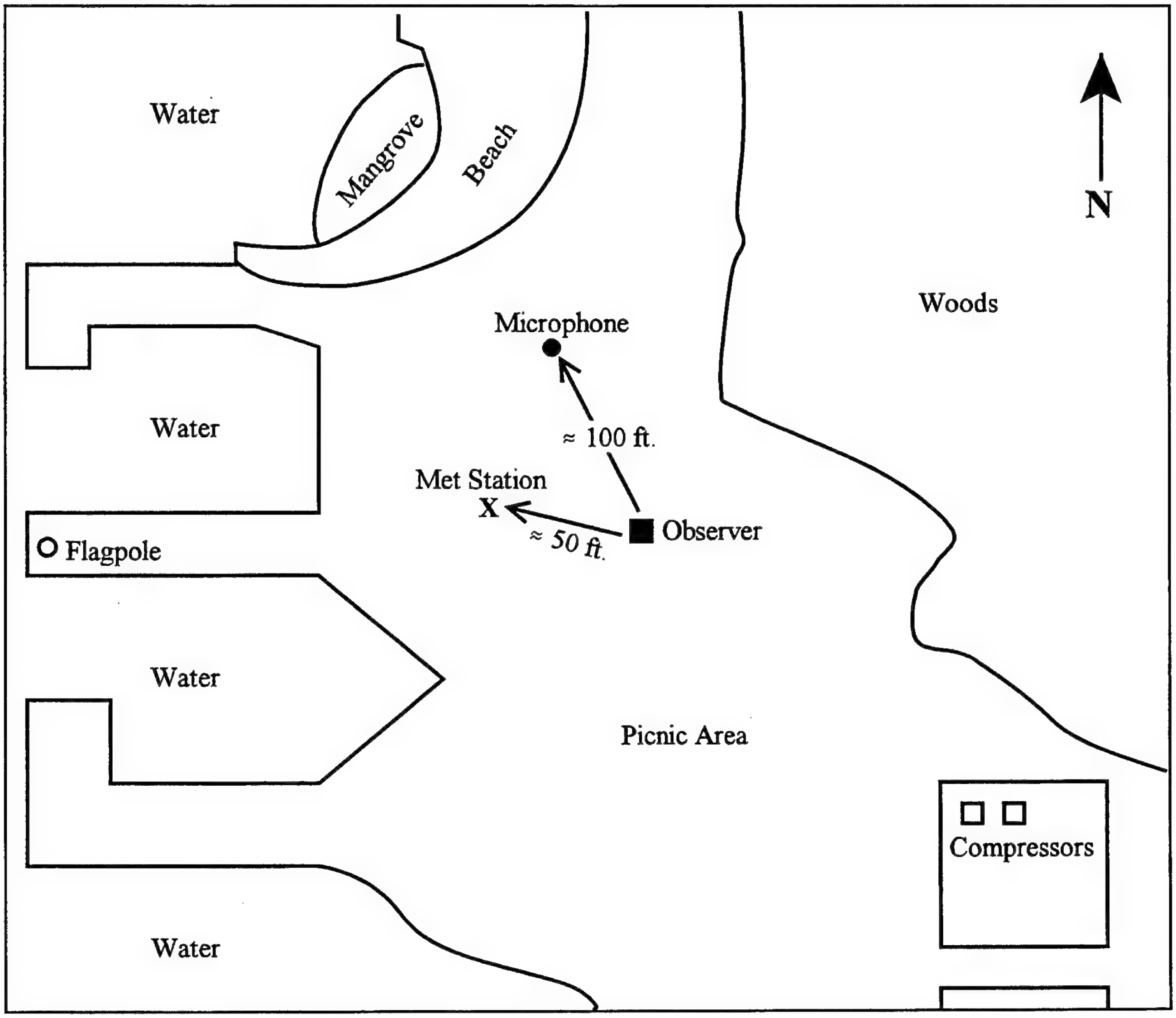


Figure 64. Plan View of Elliott Key Site

* Not to scale.

Site ID: P

Site Name: Featherbed Bank

Date(s): 8/12/98
8/14/98
8/15/98

Coordinates: 25 29 57 N / 80 14 16 W
25 31 29 N / 80 14 31 W
25 30 01 N / 80 14 16 W

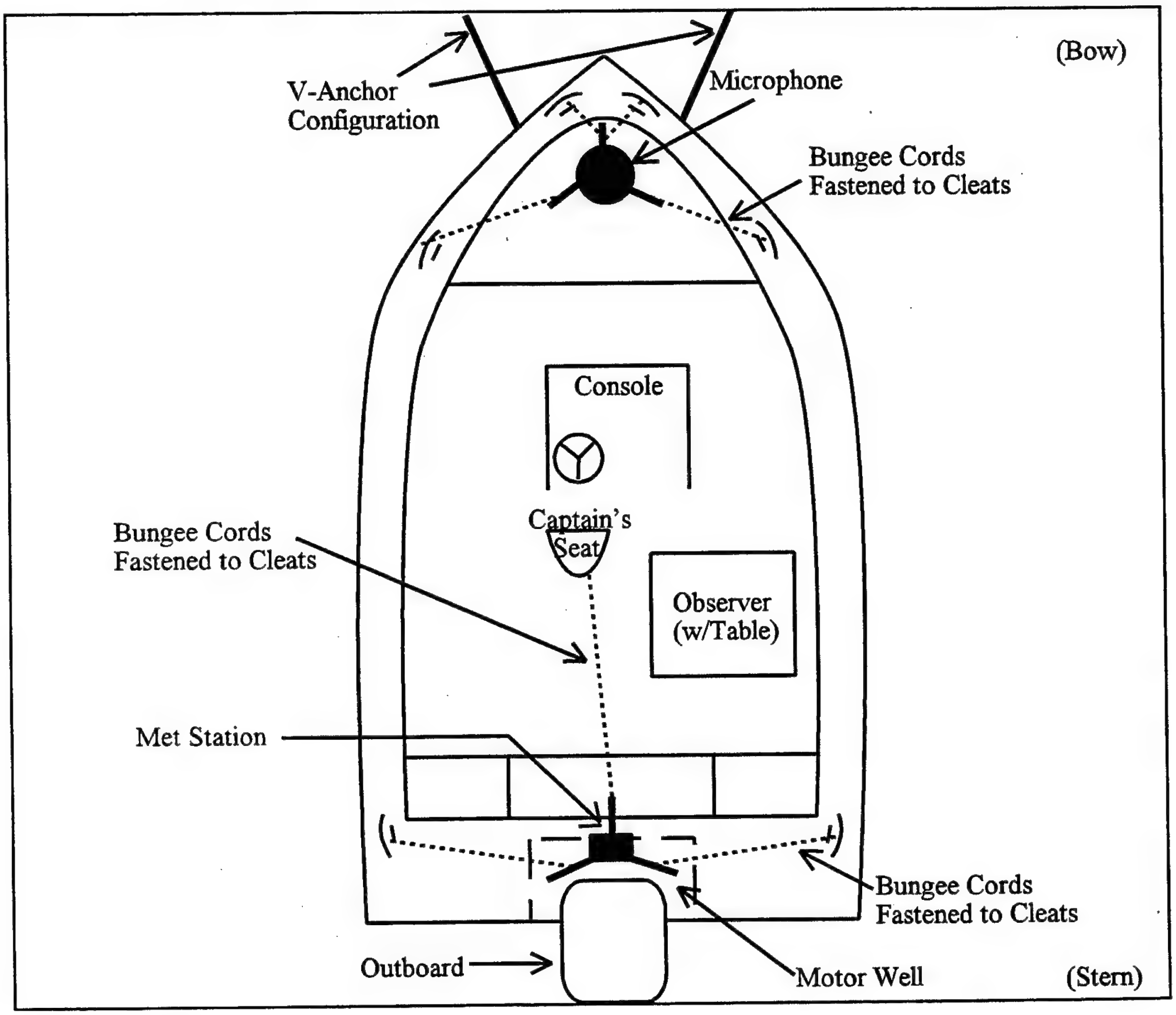


Figure 65. Plan View of Featherbed Bank Site

* Not to scale. Note: Diagram presented as representative of water-based set-ups. Set-up varied slightly between boats.

Site ID: F Site Name: Fender Point Date(s): 8/11/98
8/14/98

Coordinates: 25 28 11 N / 80 20 26 W
25 28 09 N / 80 20 26 W
25 28 09 N / 80 20 26 W

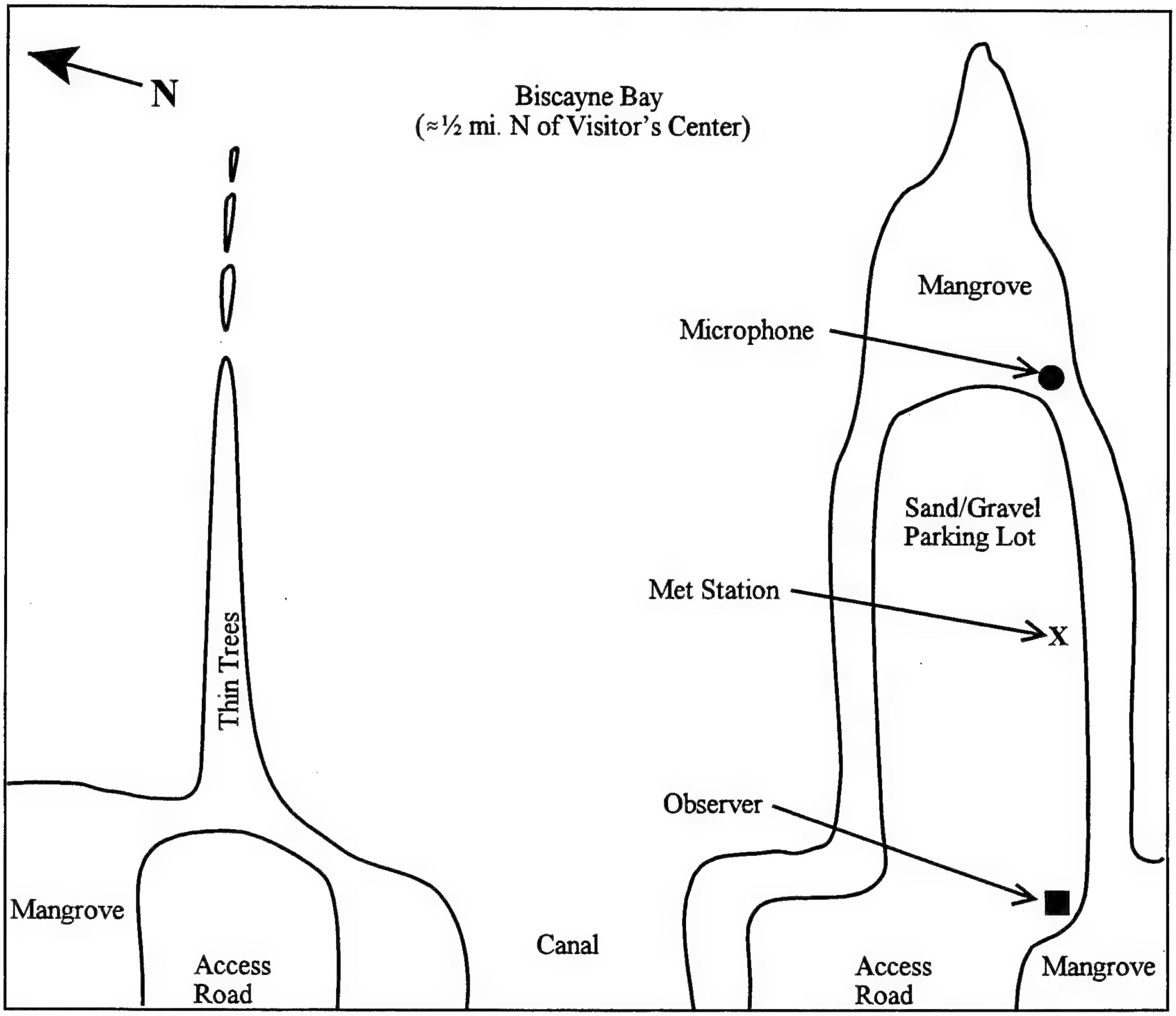


Figure 66. Plan View of Fender Point Site

* Not to scale.

Site ID: H   Site Name: Mangrove Key   Date(s): 8/11/98
8/12/98
8/15/98

Coordinates: 25 24 12 N / 80 19 04 W
25 24 12 N / 80 19 04 W
25 24 17 N / 80 18 54 W

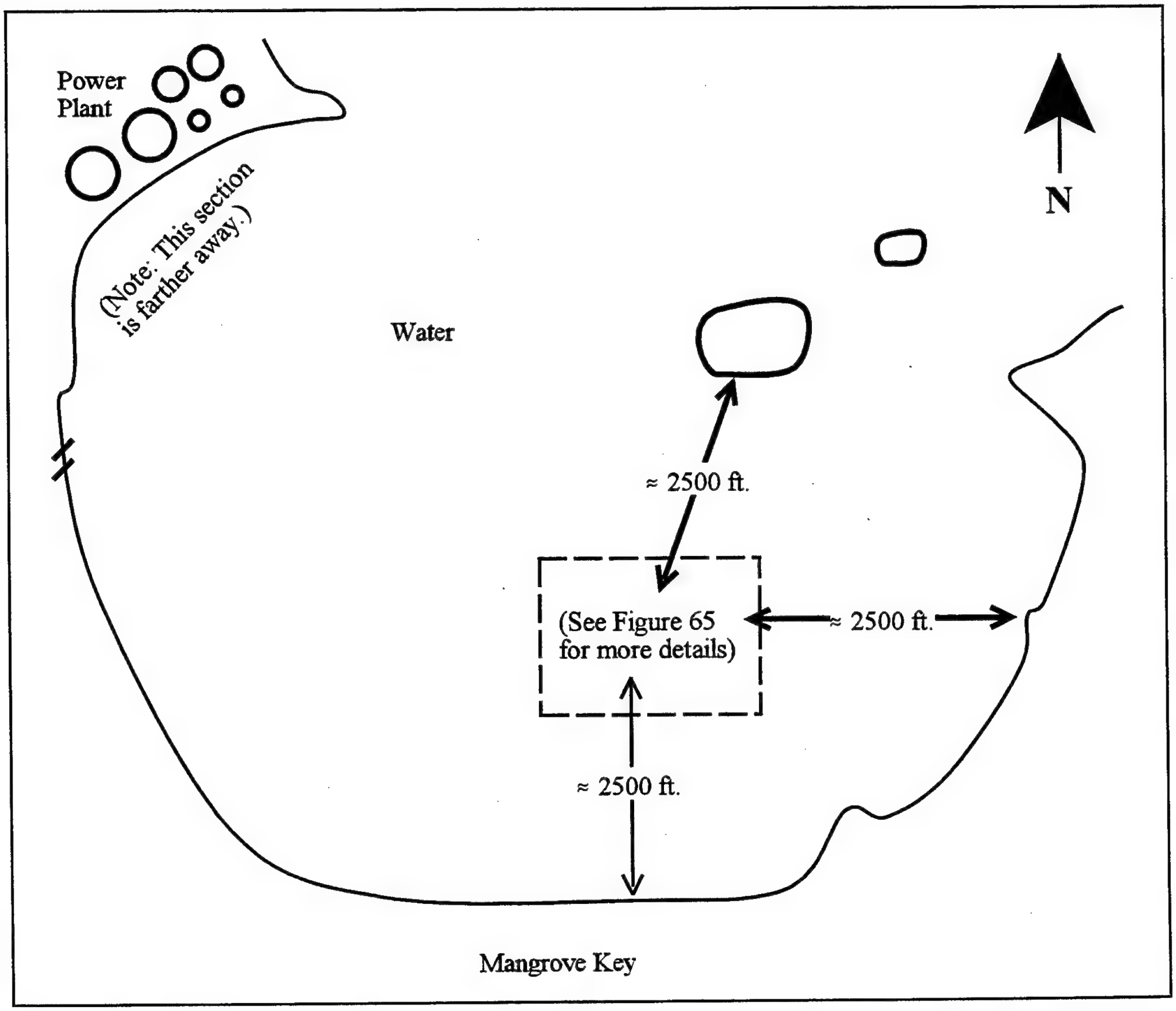


Figure 67. Plan View of Mangrove Key Site

* Not to scale.

Site ID: E Site Name: Pacific Reef Date(s): 8/11/98
8/14/98

Coordinates: 25 22 03 N / 80 08 54 W

Figure 68. Plan View of Pacific Reef Site

(Water-based measurements; see Figure 65)

Site ID: D   Site Name: Rubicon Key   Date(s): 8/11/98
8/14/98

Coordinates: 25 23 27 N / 80 13 58 W
25 23 31 N / 80 14 01 W

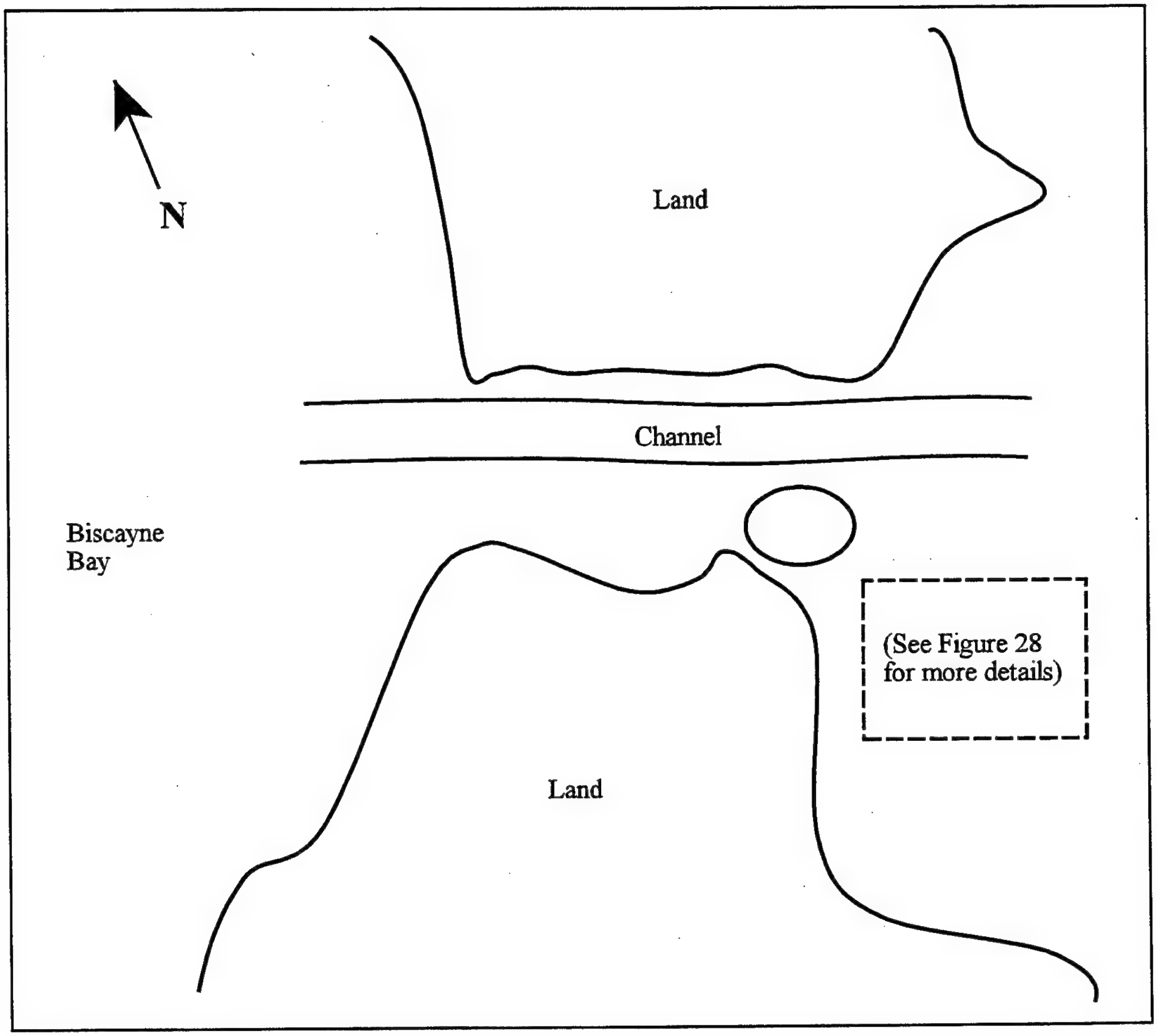


Figure 69. Plan View of Rubicon Key Site

* Not to scale.

Site ID: L   Site Name: Soldier Key   Date(s): 8/13/98
8/16/98

Coordinates: 25 35 28 N / 80 09 39 W

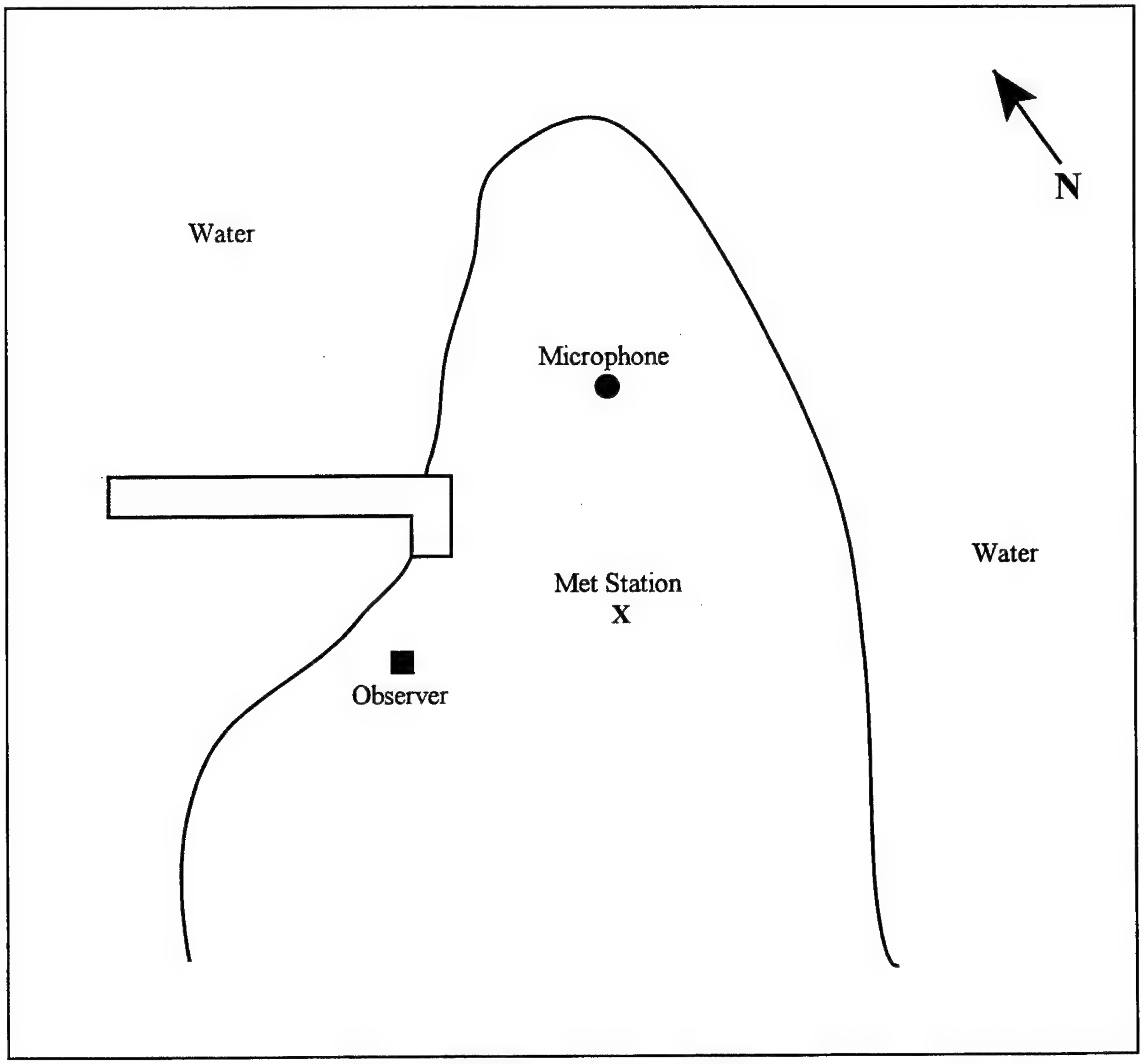


Figure 70. Plan View of Soldier Key Site

* Not to scale.

Site ID: J   Site Name: Stiltsville   Date(s): 8/12/98
8/16/98
8/17/98

Coordinates: 25 37 18 N / 80 08 54 W
25 37 17 N / 80 08 57 W
25 37 45 N / 80 12 06 W

(Water-based measurements; see Figure 65)

Figure 71. Plan View of Stiltsville Site

Site ID: G   Site Name: Biscayne Visitors Center   Date(s): 8/11/98
8/16/98

Coordinates: 25 27 52 N / 80 20 05 W

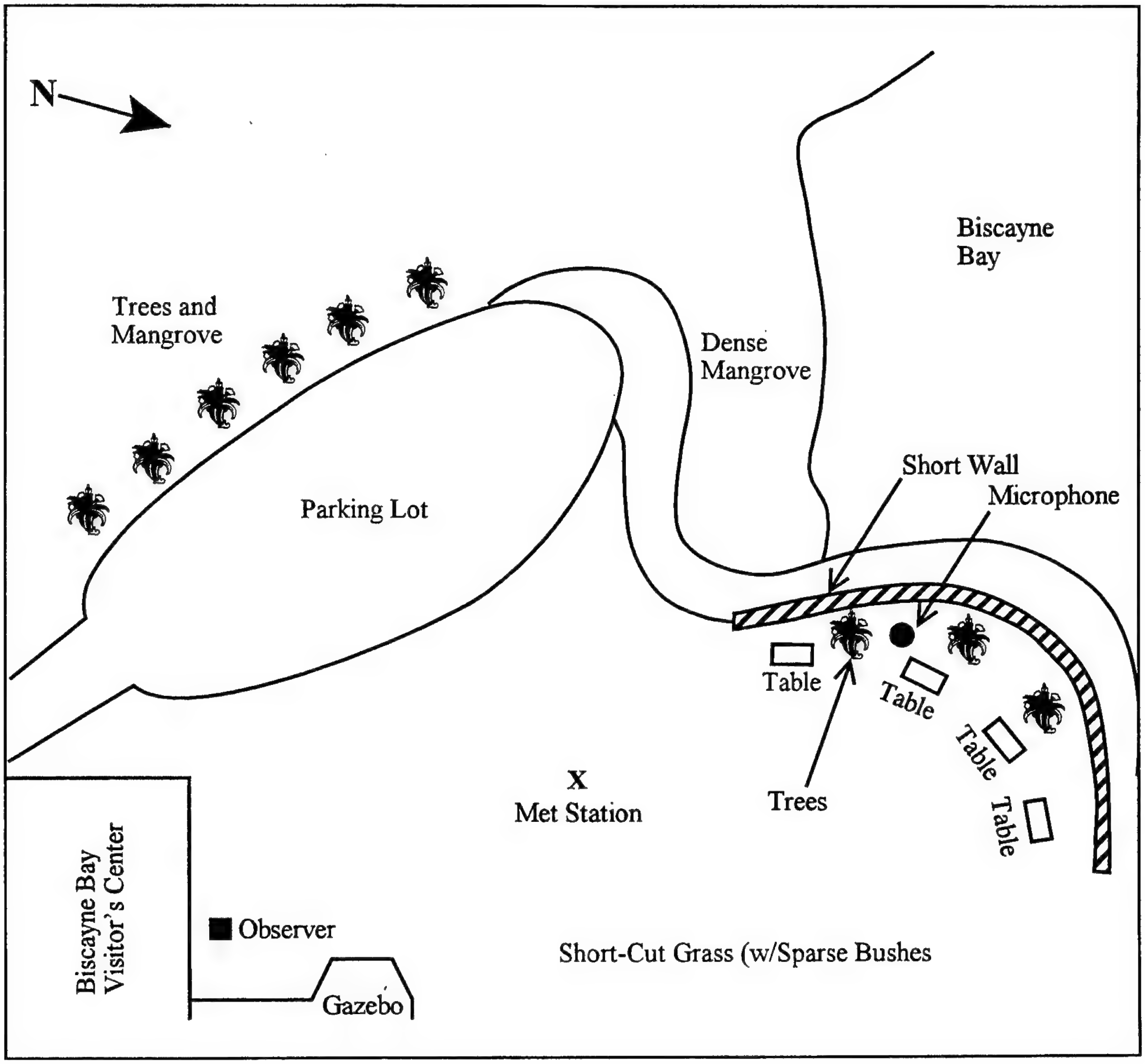


Figure 72. Plan View of Biscayne Visitors Center Site

* Not to scale.

Site ID: B   Site Name: Anhinga Trail   Date(s): 8/10/98
8/12/98
8/15/98

Coordinates: 25 23 01 N / 80 36 22 W

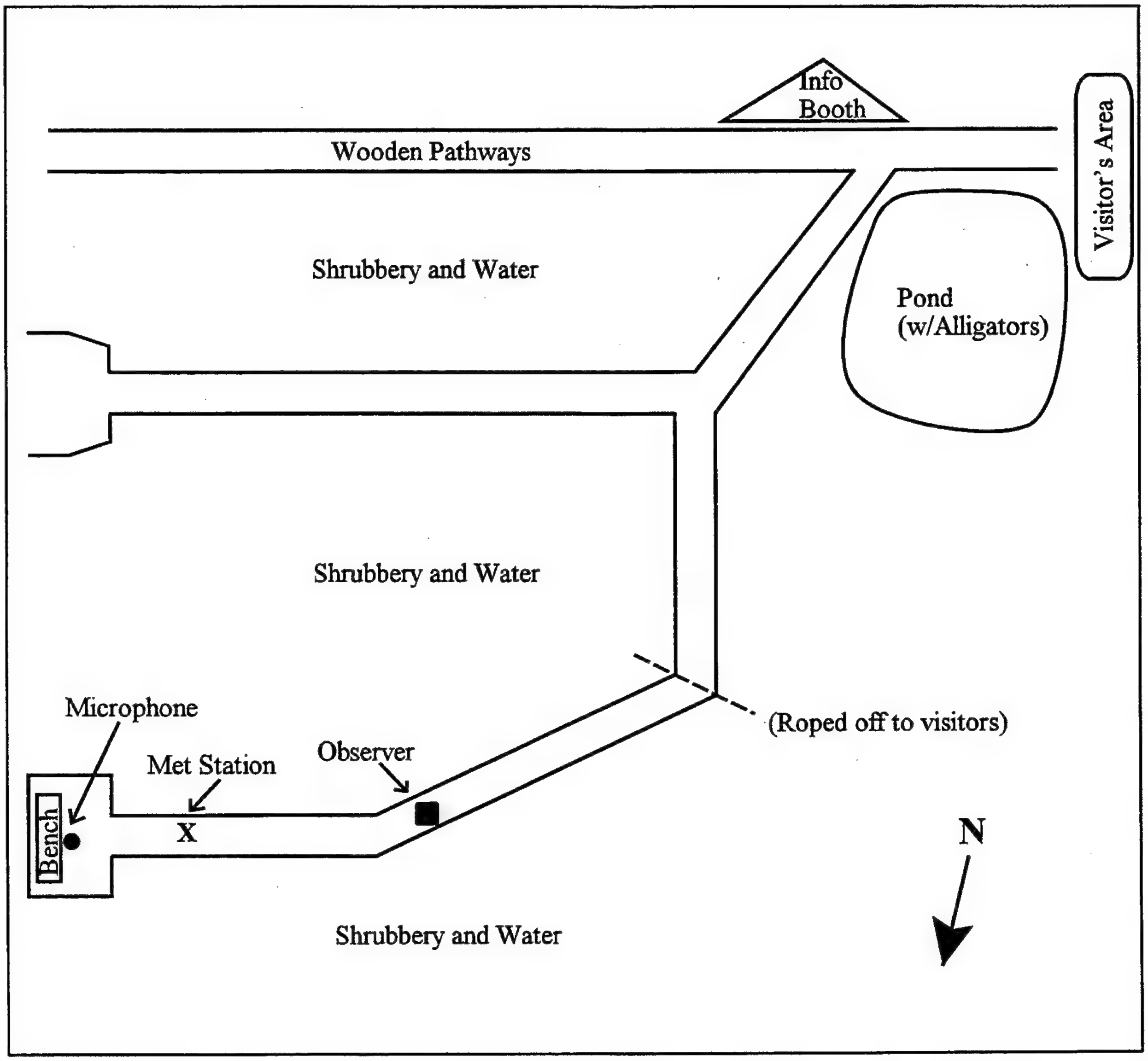


Figure 73. Plan View of Anhinga Trail Site

* Not to scale.

Site ID: Y   Site Name: Buchanan Key   Date(s): 8/19/98

Coordinates: 24 54 58 N / 80 46 29 W

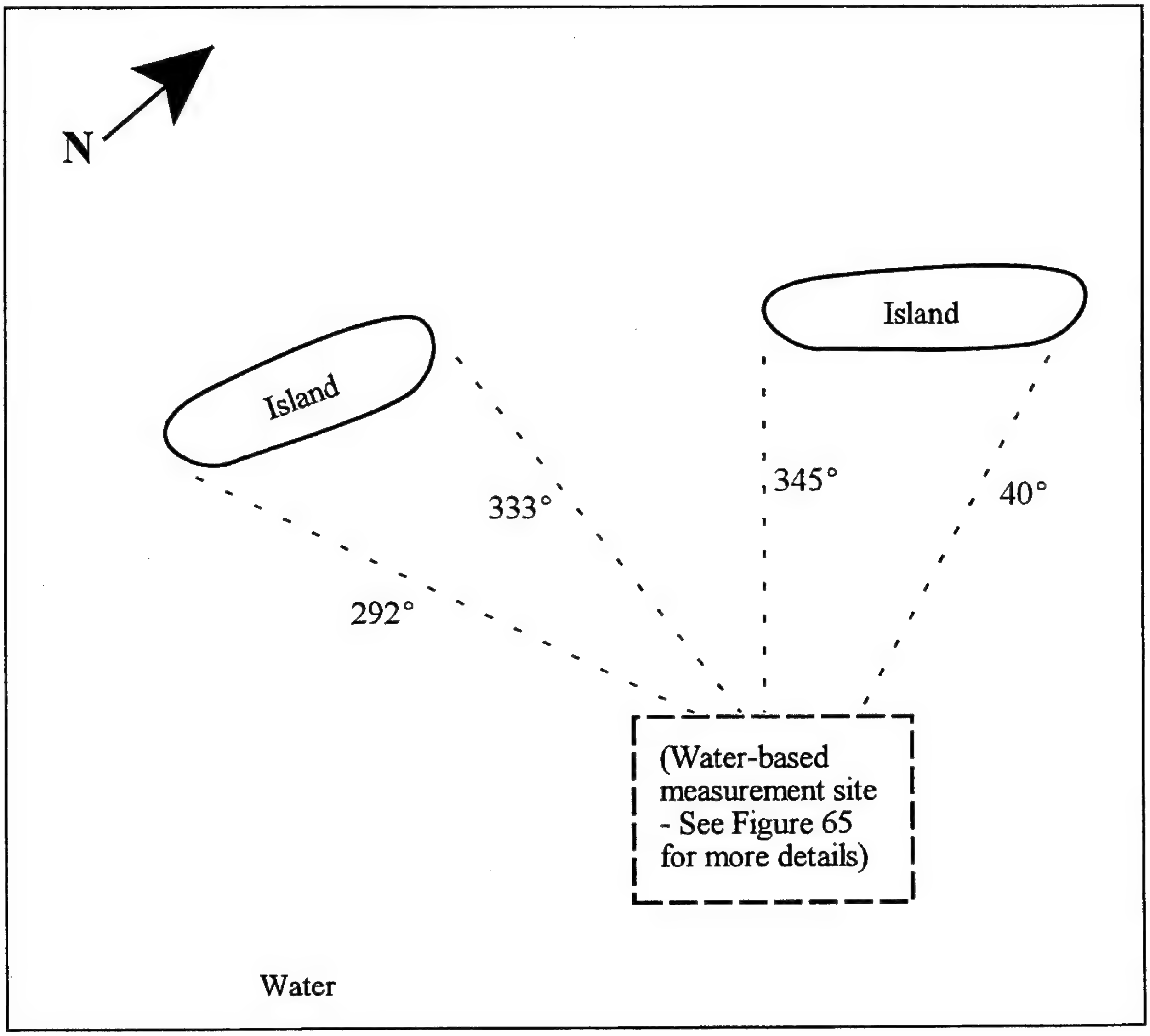


Figure 74. Plan View of Buchanan Key Site

* Not to scale.

Site ID: O   Site Name: Chekika   Date(s): 8/10/98
8/27/98

Coordinates: 25 36 45 N / 80 35 04 W

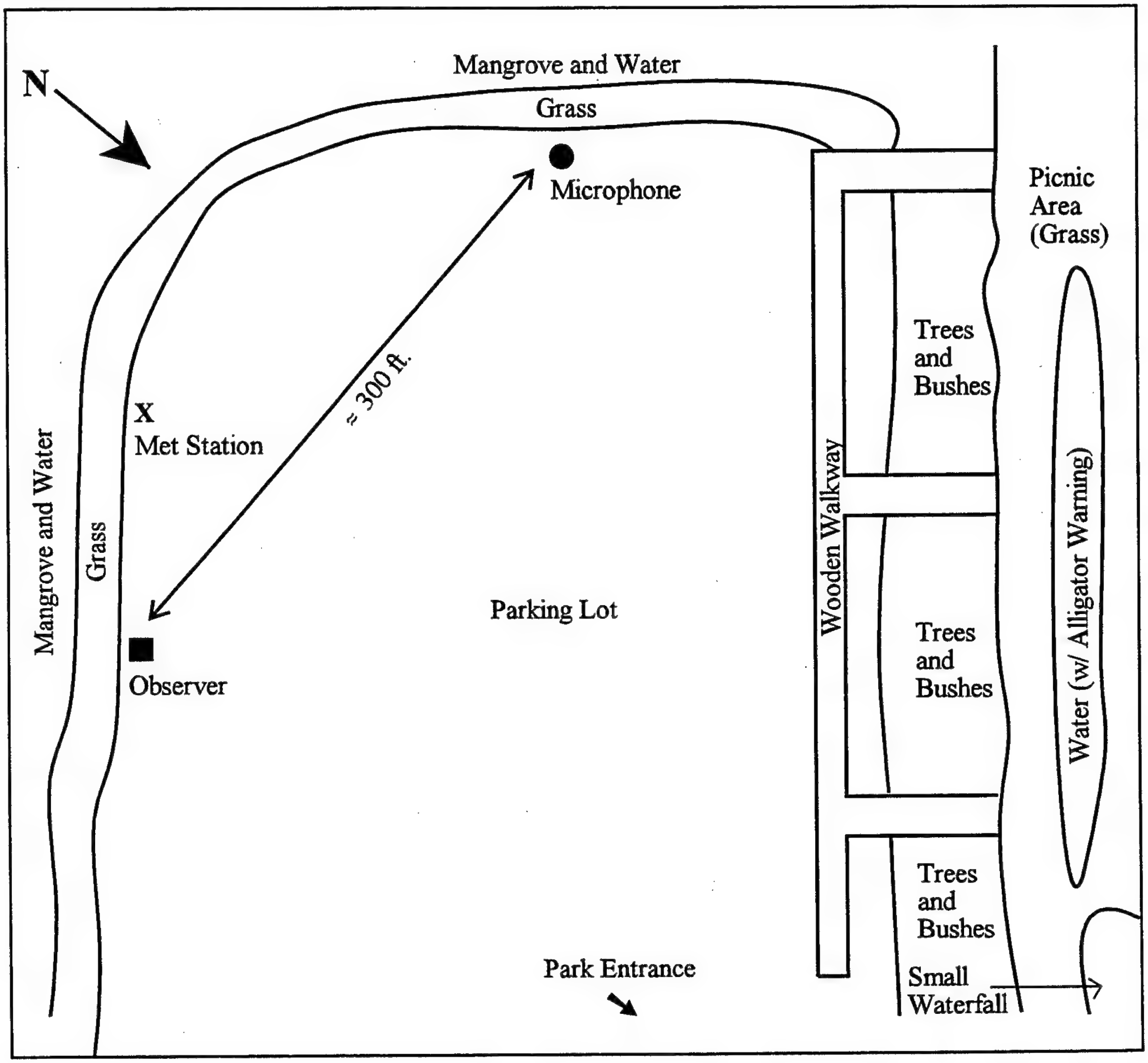


Figure 75. Plan View of Chekika Site

* Not to scale.

Site ID: M   Site Name: Eastern Panhandle   Date(s): 8/13/98

Coordinates: 25 17 16 N / 80 26 30 W

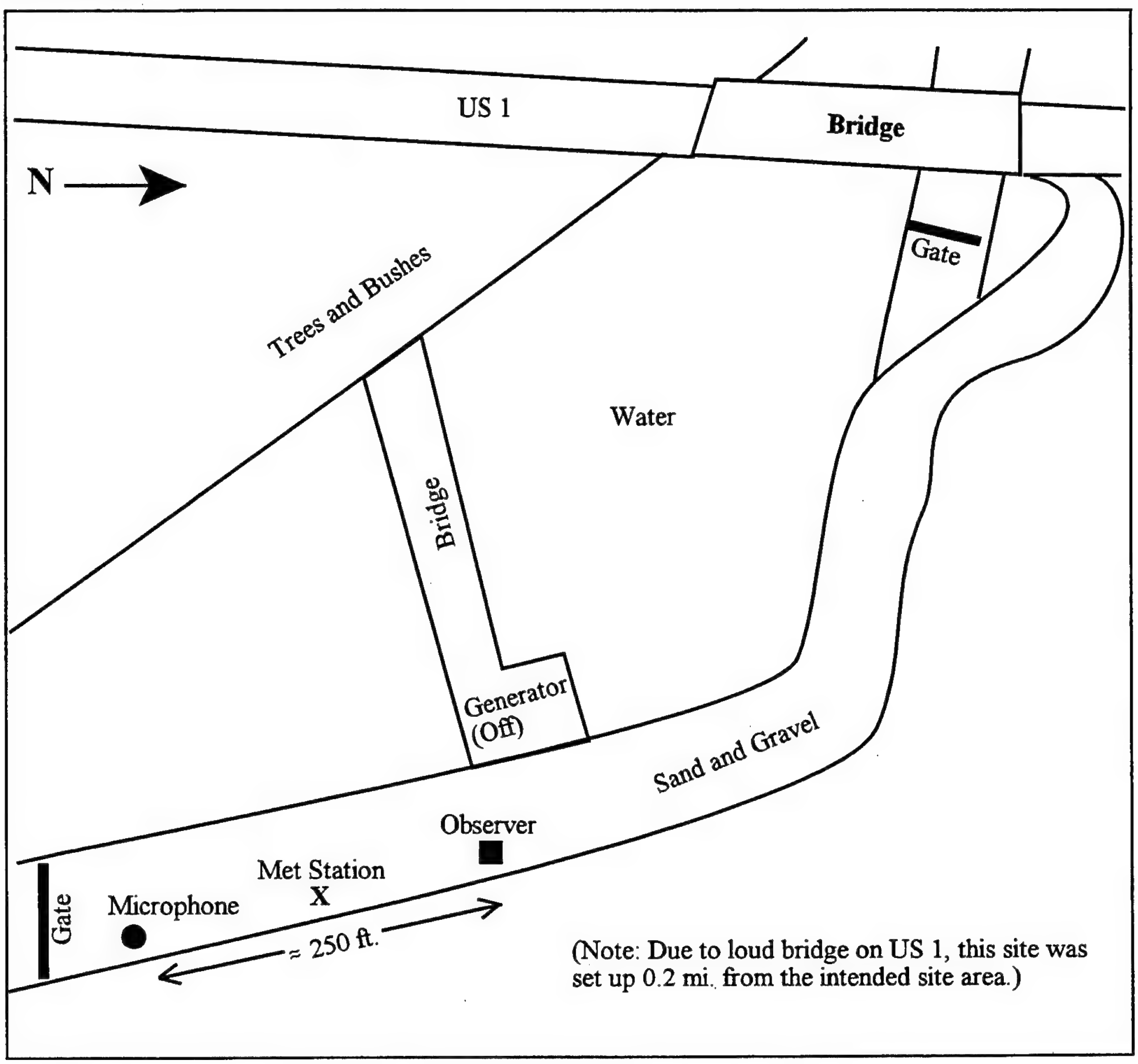


Figure 76. Plan View of Eastern Panhandle Site

* Not to scale.

Site ID: V Site Name: Eastern Sparrow Date(s): 8/18/98

Coordinates: 25 29 52 N / 80 39 45 W

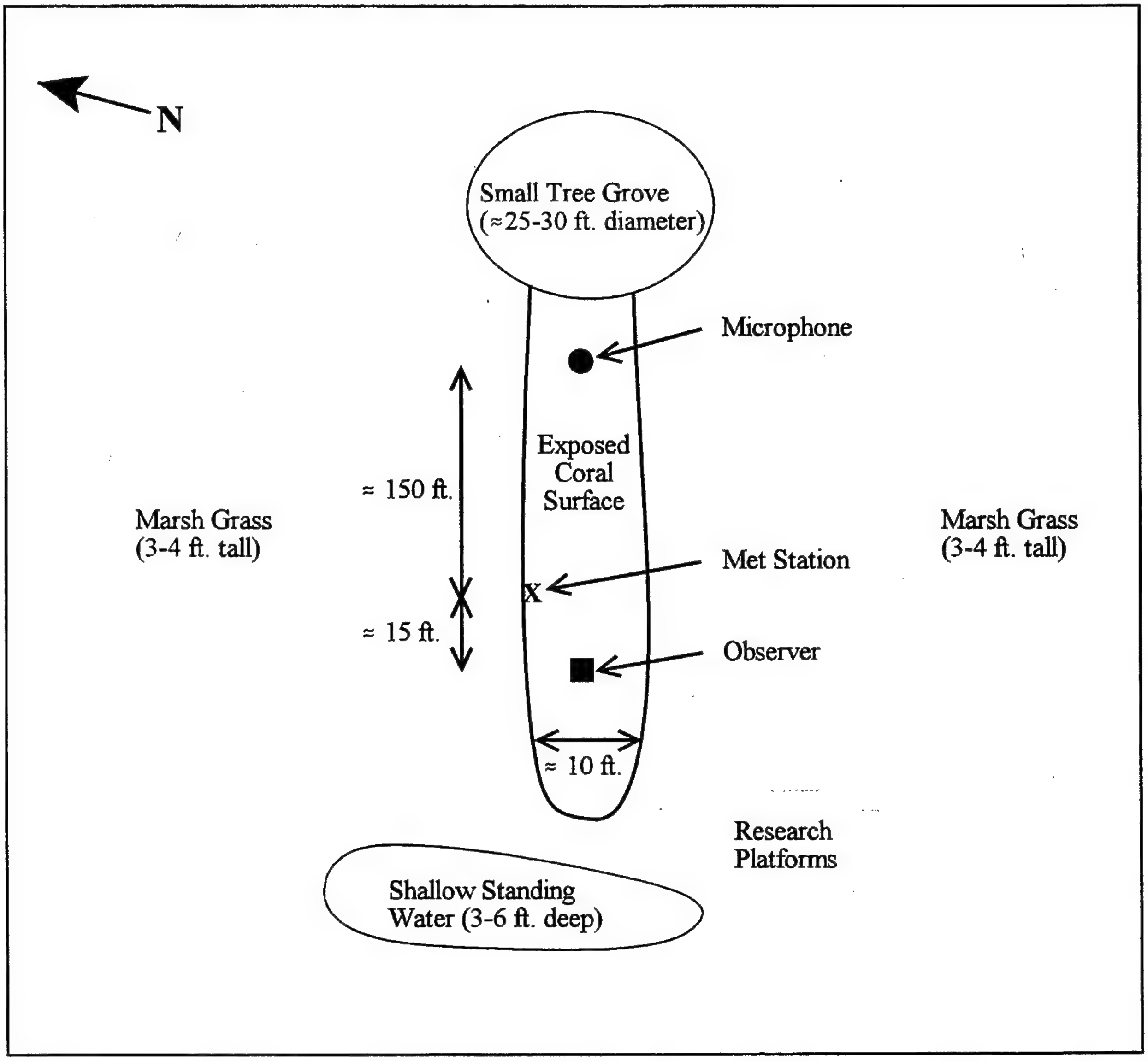


Figure 77. Plan View of Eastern Sparrow Site

* Not to scale.

Site ID: Q   Site Name: Eco Pond   Date(s): 8/14/98

Coordinates: 25 08 19 N / 80 56 16 W

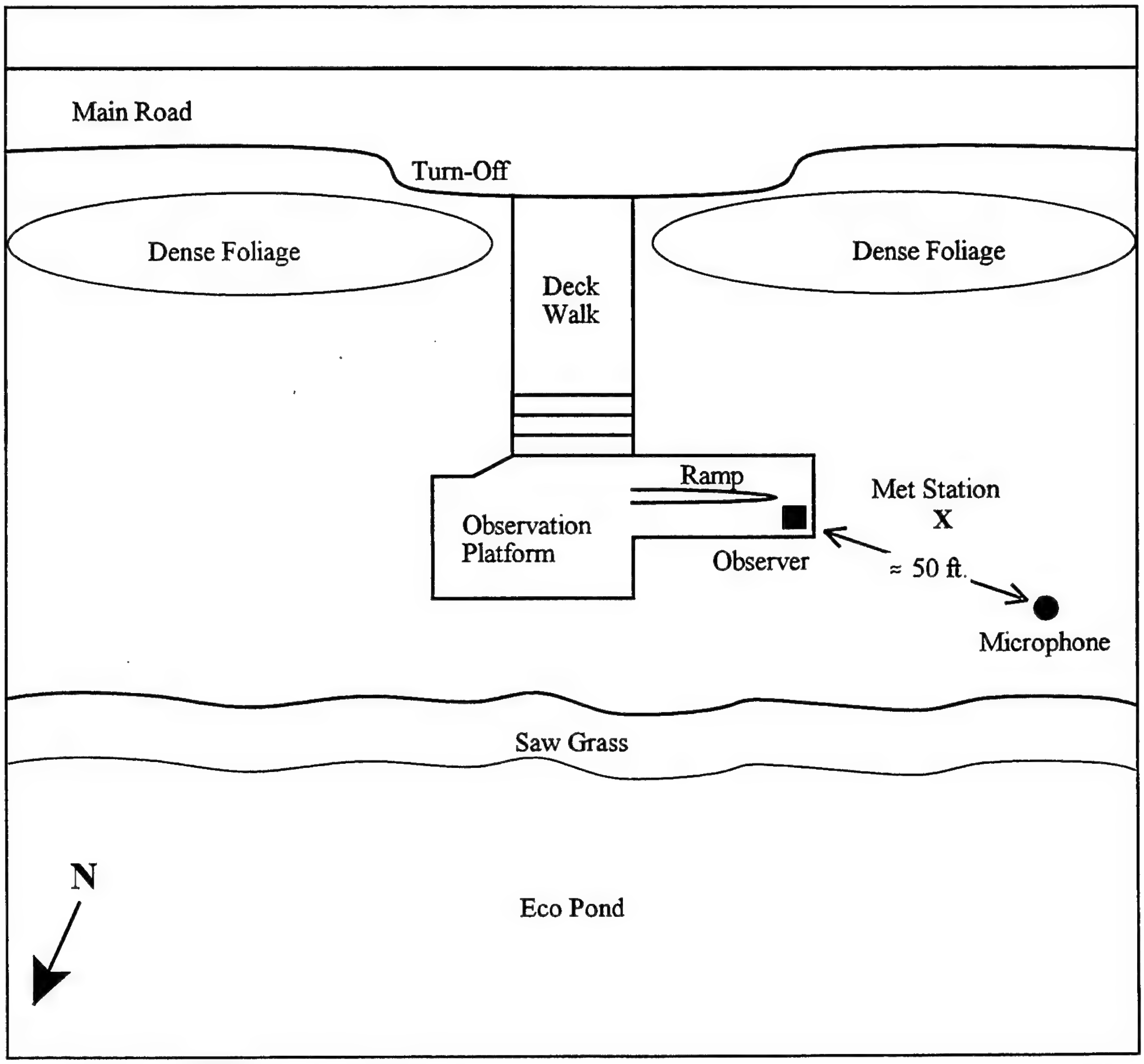


Figure 78. Plan View of Eco Pond Site

* Not to scale.

Site ID: R Site Name: Hidden Lake Date(s): 8/15/98
8/17/98

Coordinates: 25 22 55 N / 80 37 06 W

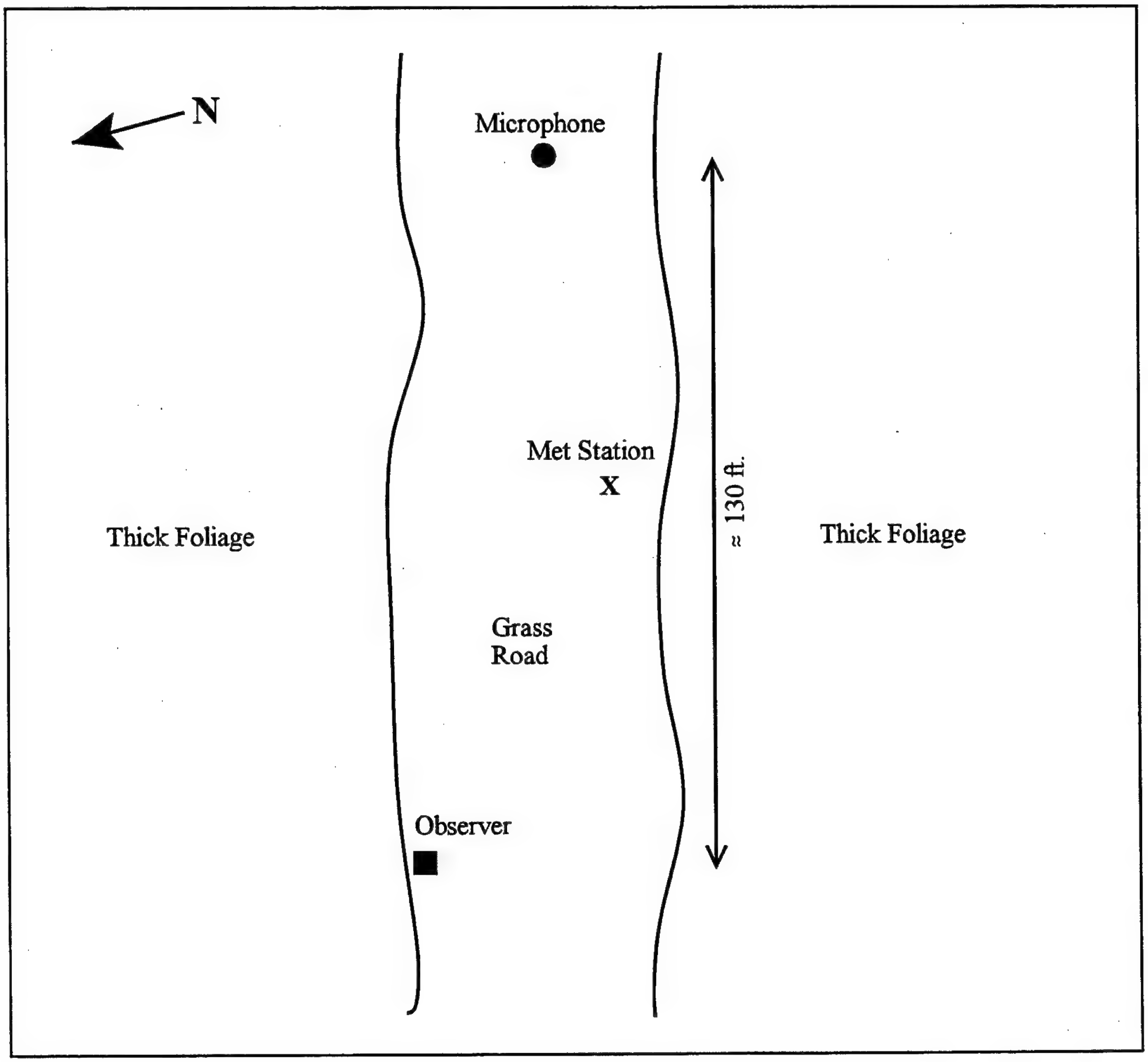


Figure 79. Plan View of Hidden Lake Site

* Not to scale.

Site ID: U Site Name: Little Madeira Bay Date(s): 8/18/98
8/20/98

Coordinates: 25 11 45 N / 80 37 42 W
25 10 53 N / 80 38 21 W

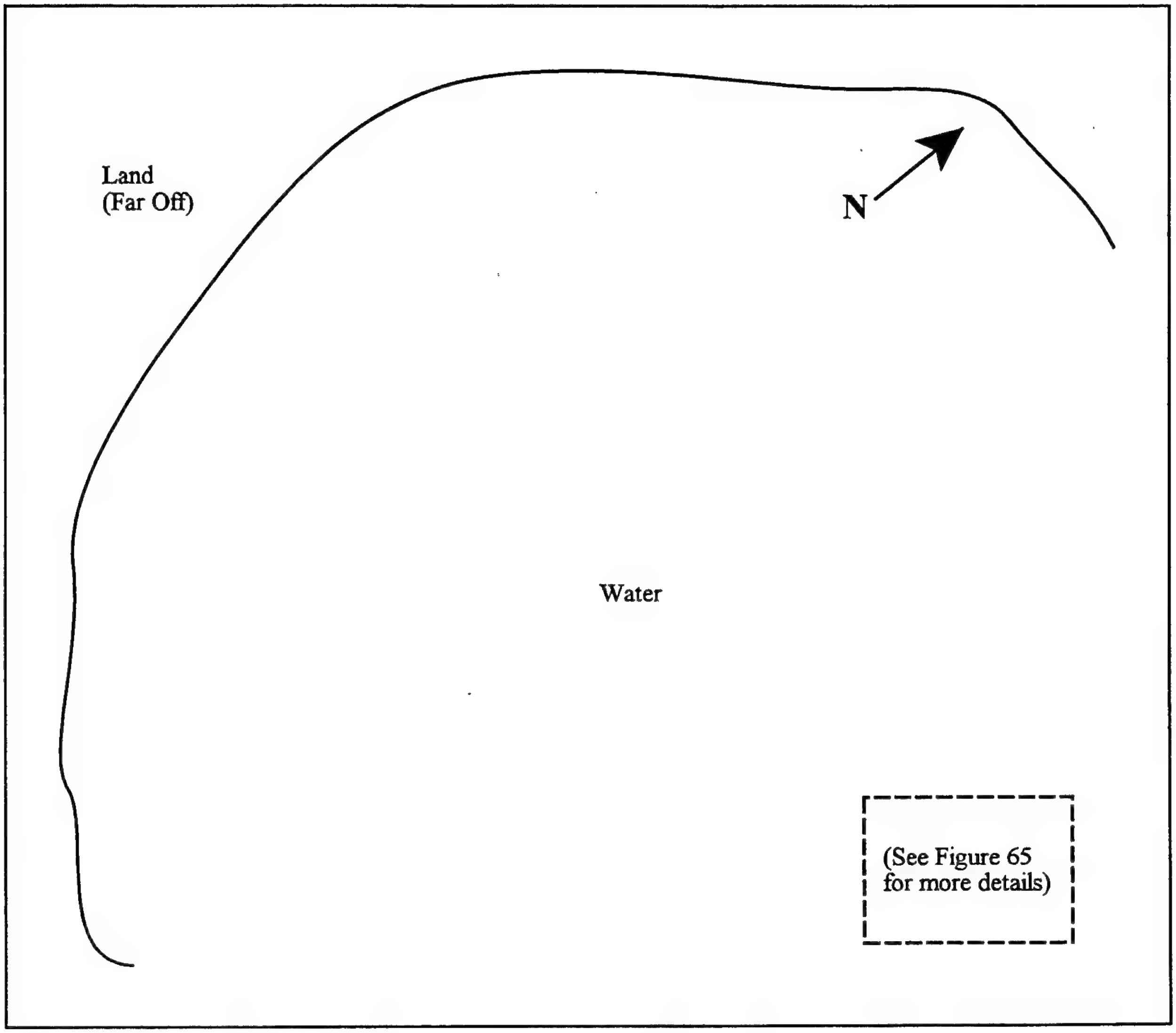


Figure 80. Plan View of Little Madeira Bay Site

* Not to scale.

Site ID: X   Site Name: North Nest Key   Date(s): 8/18/98

Coordinates: 25 09 06 N / 80 30 41 W

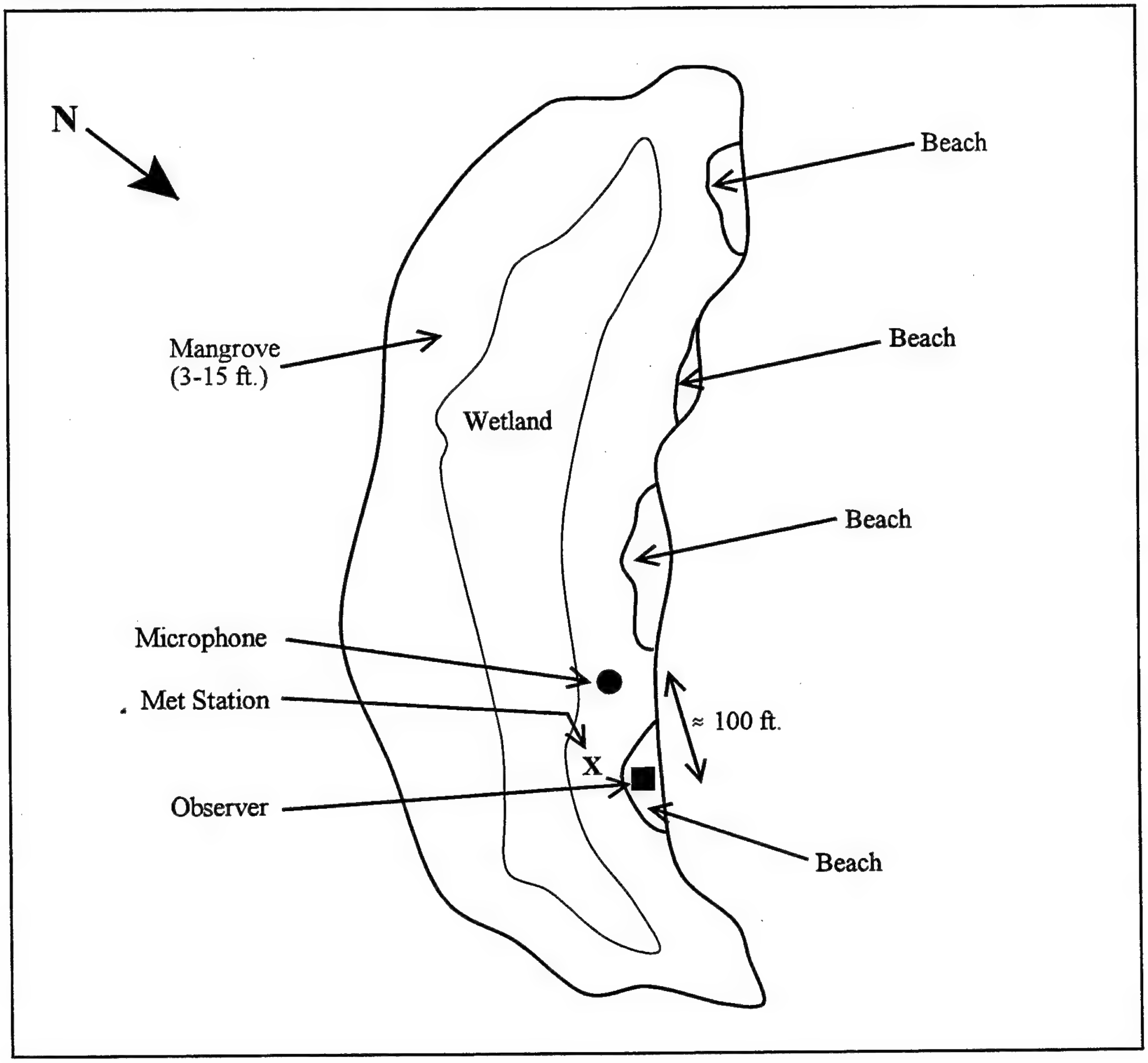


Figure 81. Plan View of North Nest Key Site

* Not to scale.

Site ID: AA Site Name: Pavilion Key Date(s): 8/20/98

Coordinates: 25 42 31 N / 81 21 03 W

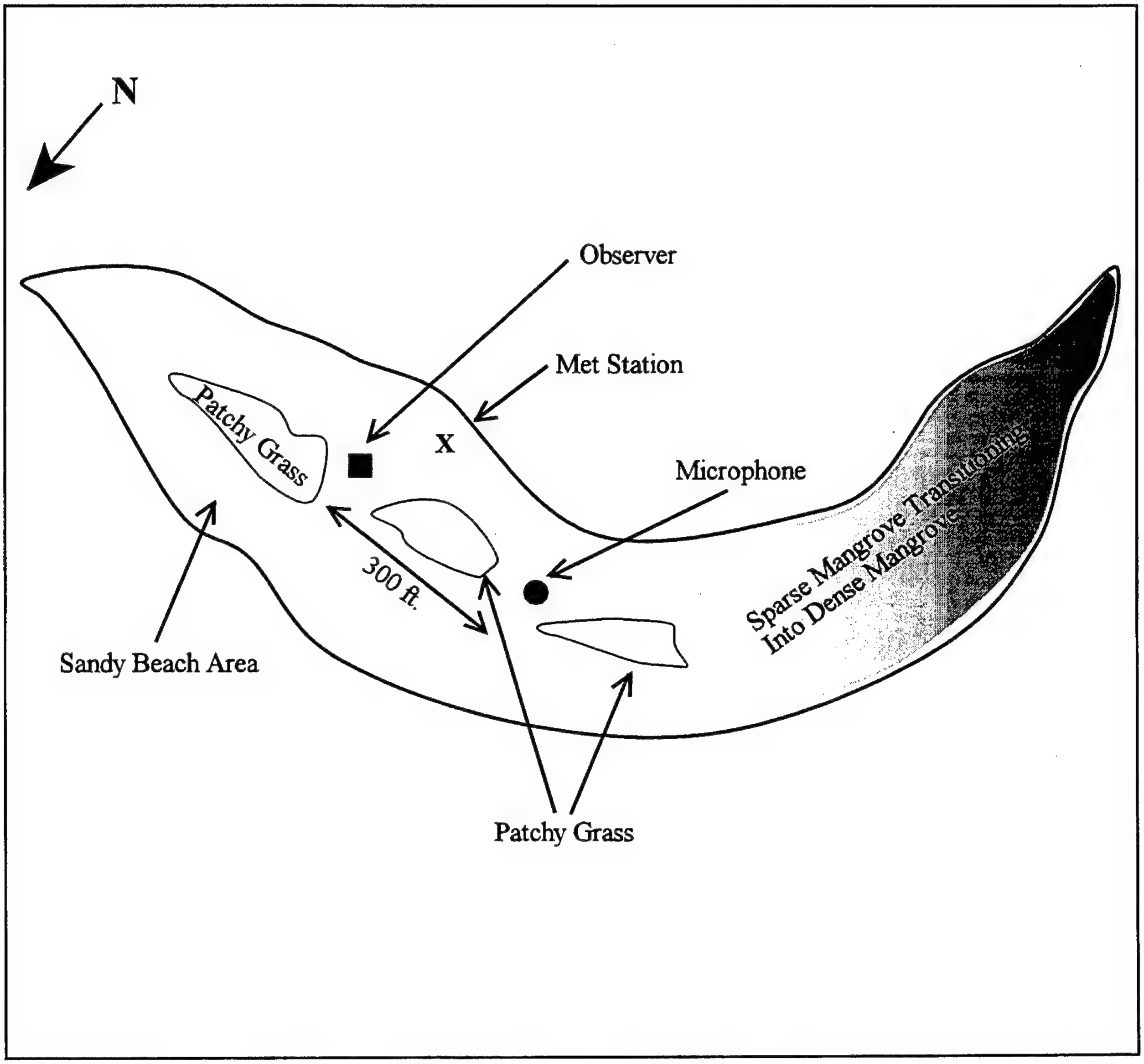


Figure 82. Plan View of Pavilion Key Site

* Not to scale.

Site ID: K

Site Name: Pinelands

Date(s): 8/12/98
8/13/98
8/19/98

Coordinates: 25 25 22 N / 80 40 47 W

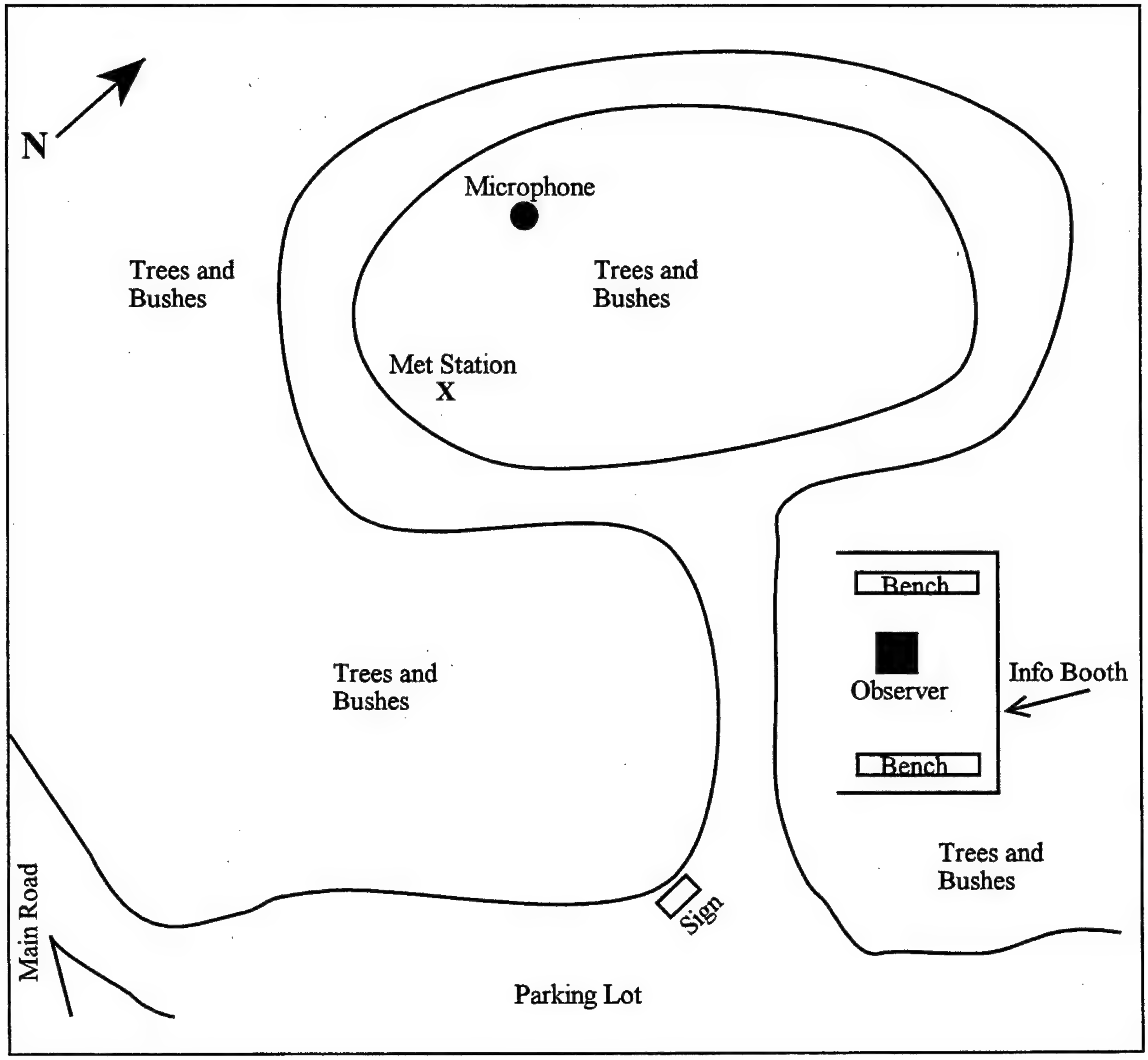
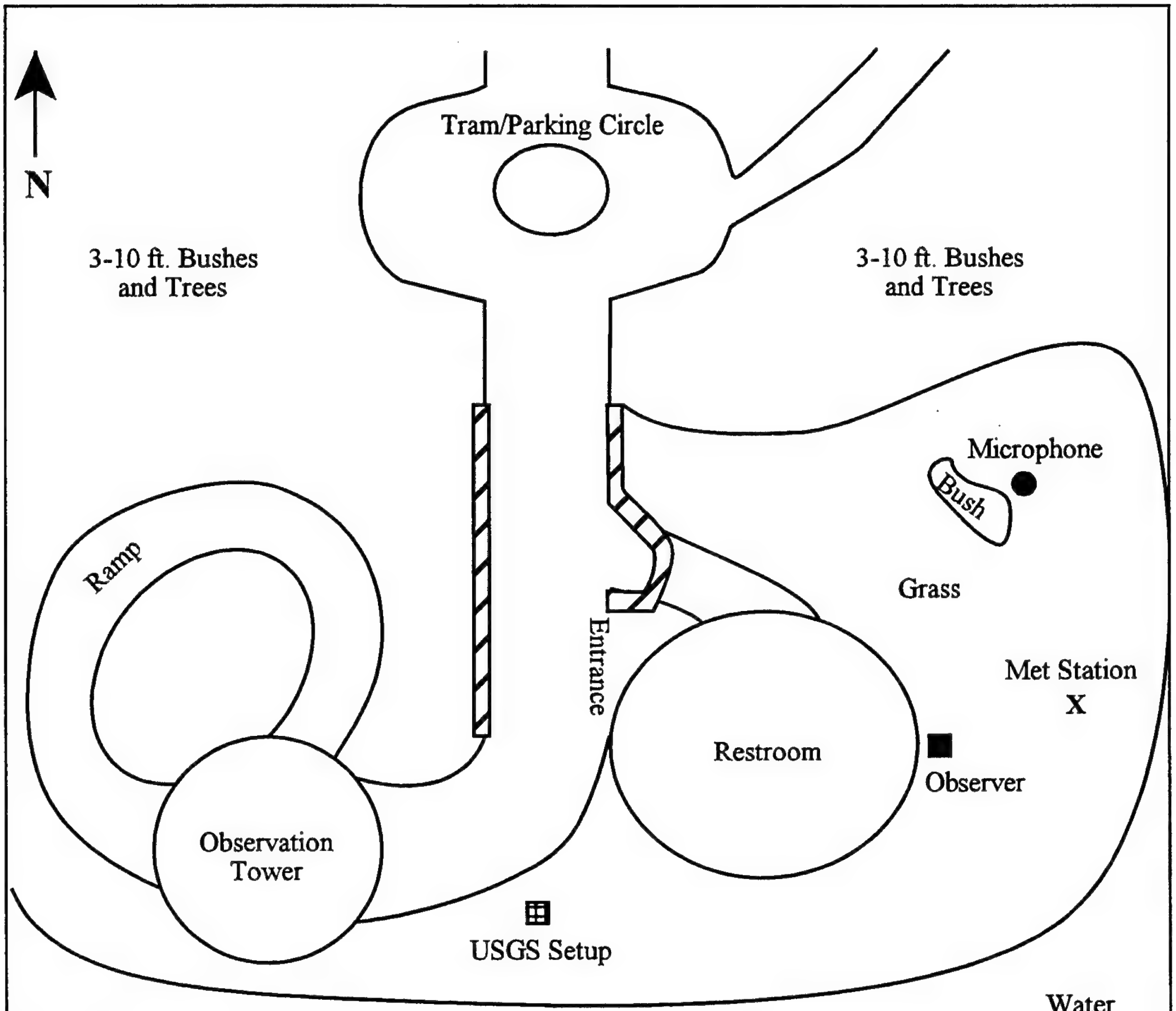


Figure 83. Plan View of Pinelands Site

* Not to scale.

Site ID: N Site Name: Shark Valley Date(s): 8/13/98
8/16/98

Coordinates: 25 39 23 N / 80 45 59 W



(Note: This site is actually 4.15 mi. southwest of NPS coordinates.)

Figure 84. Plan View of Shark Valley Site

* Not to scale.

<u>Site ID</u>: T   <u>Site Name</u>: Whitewater Bay   <u>Date(s)</u>: 8/17/98

<u>Coordinates</u>: 25 14 48 N / 80 57 51 W

(Water-based measurements; see Figure 65)

Figure 85. Plan View of Whitewater Bay Site

Site ID: AD Site Name: Barnes Sound Date(s): 8/19/98

Coordinates: 25 14 29 N / 80 20 03 W

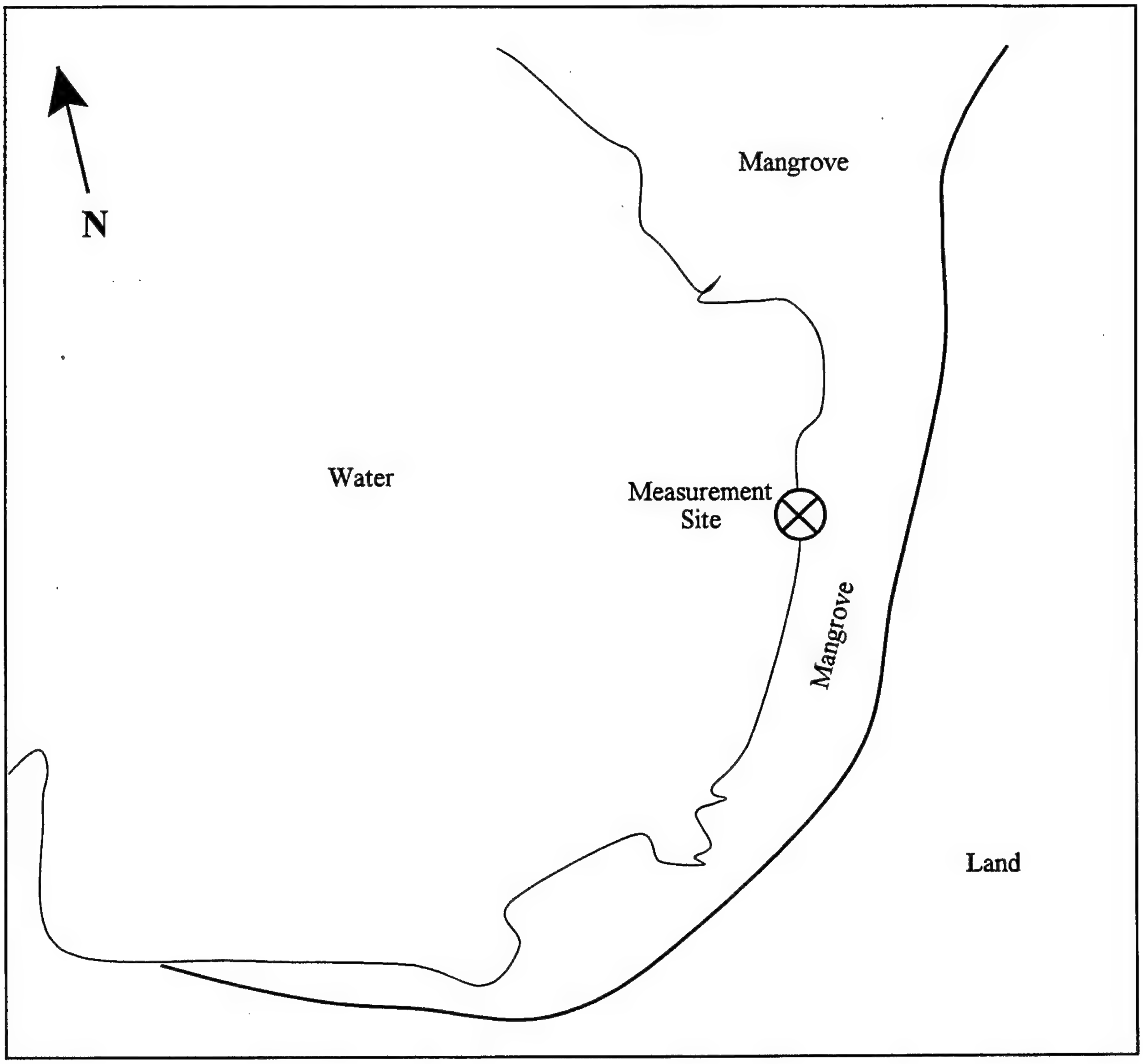


Figure 86. Plan View of Barnes Sound Site

* Not to scale.

Site ID: W   Site Name: Hardwood Hammock   Date(s): 8/18/98

Coordinates: 25 15 56 N / 80 18 39 W

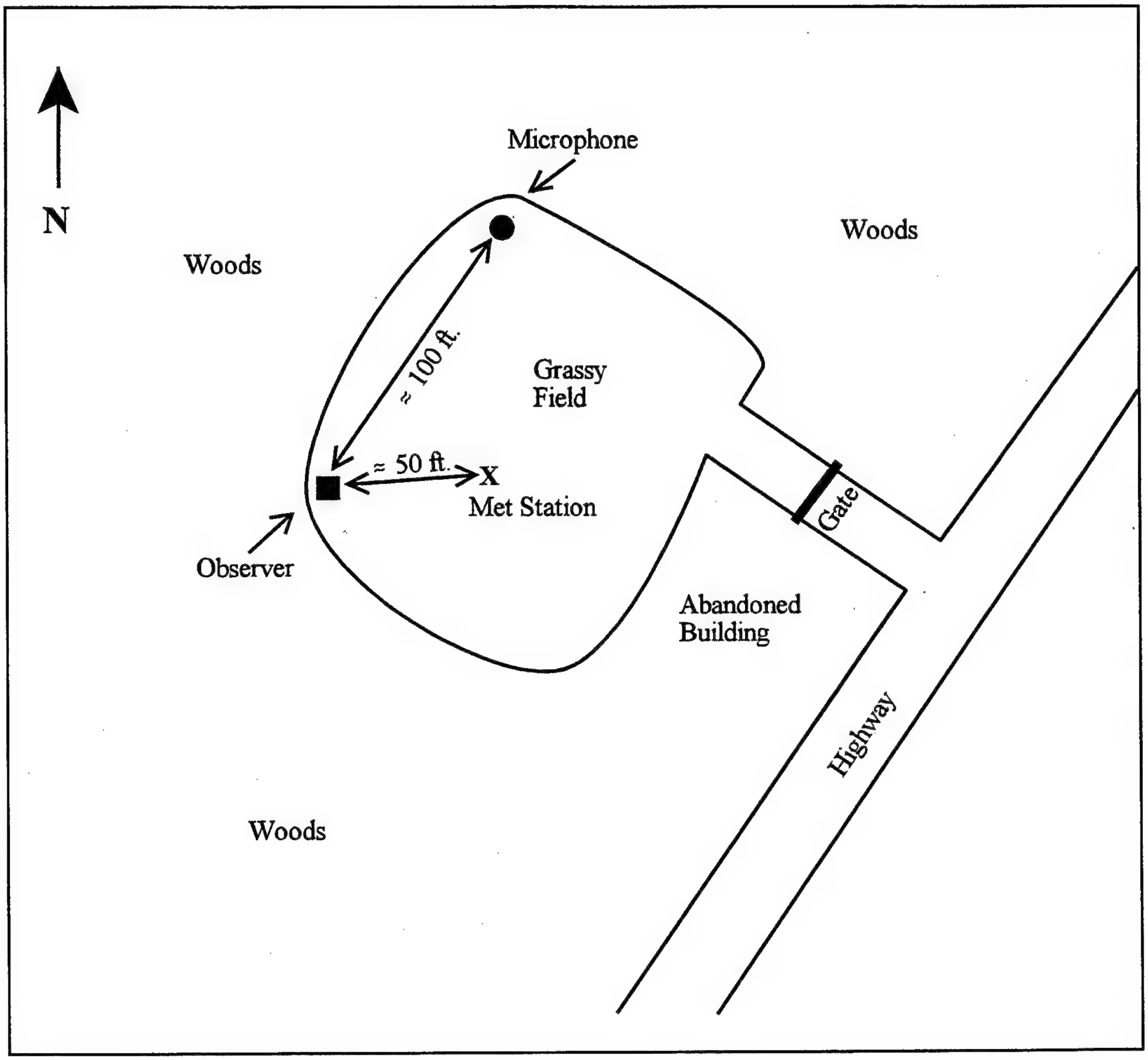


Figure 87. Plan View of Hardwood Hammock Site

* Not to scale.

Site ID: AC Site Name: Mangrove Inlet Date(s): 8/18/98

Coordinates: 25 13 36 N / 80 20 01 W

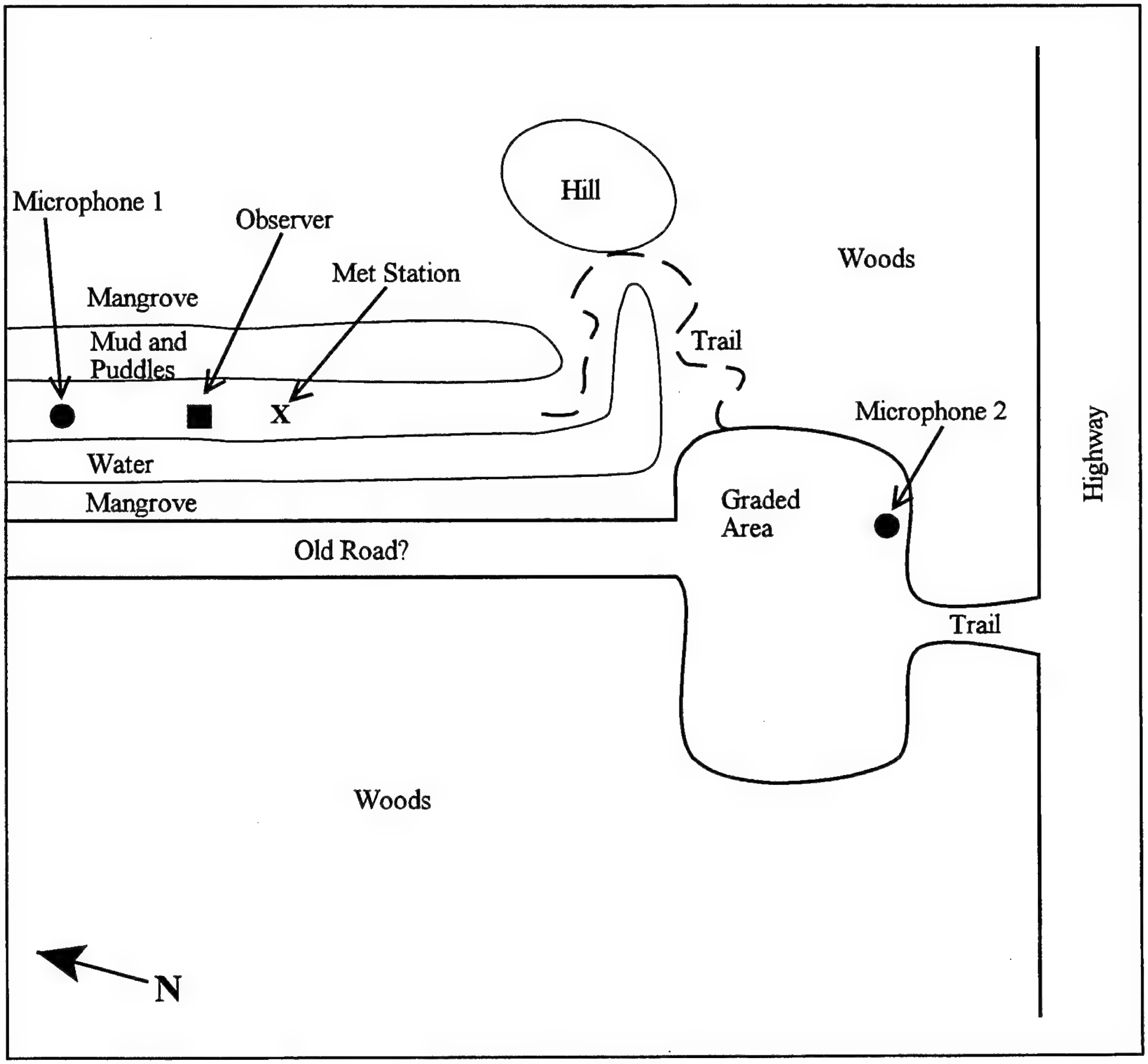


Figure 88. Plan View of Mangrove Inlet Site

* Not to scale.

Site ID: S   Site Name: Golightly Campground   Date(s): 8/16/98
8/17/98

Coordinates: 25 45 17 N / 80 55 35 W

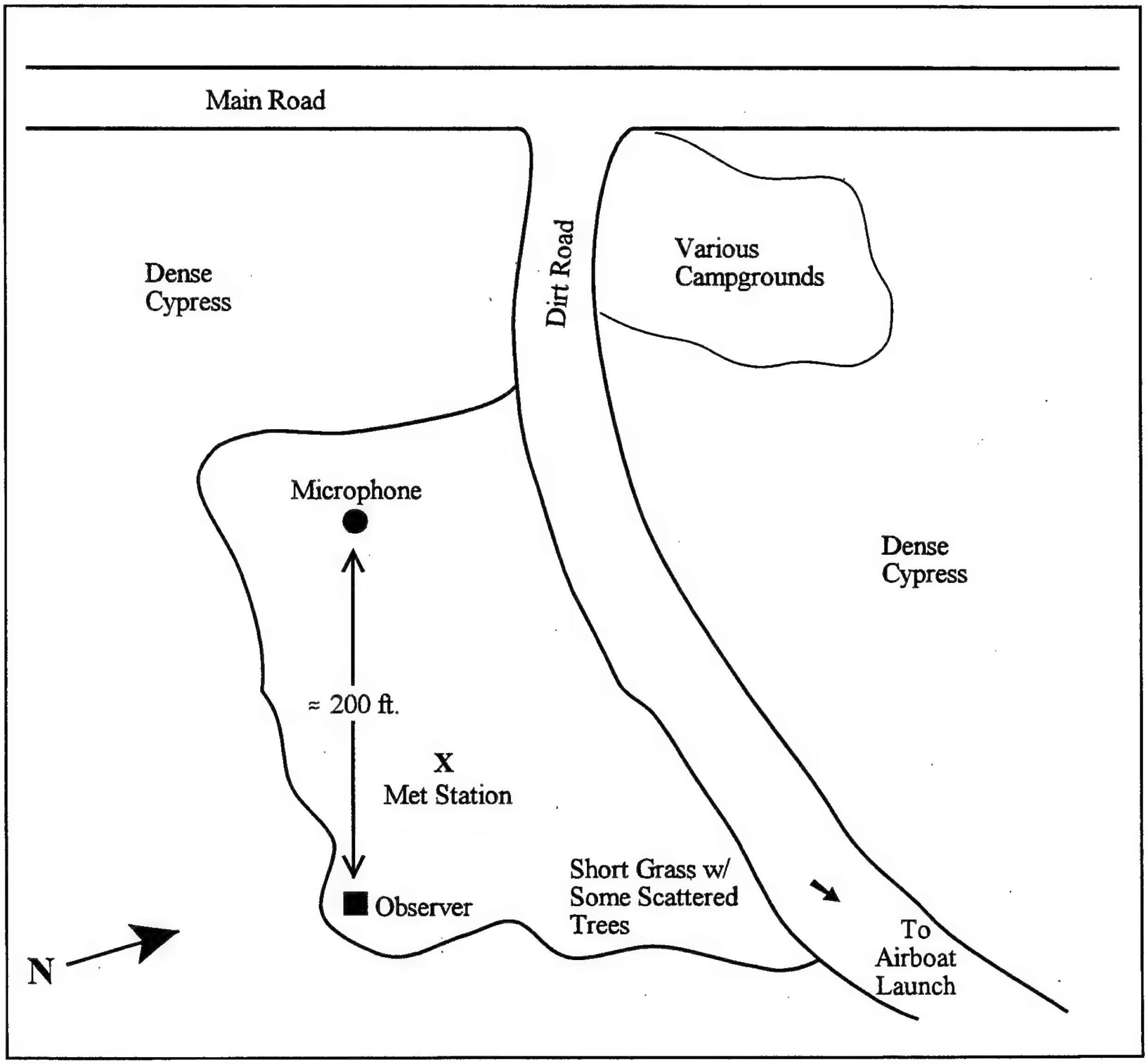


Figure 89. Plan View of Golightly Campground Site

* Not to scale.

Site ID: AE Site Name: National Scenic Trail Date(s): 8/20/98

Coordinates: 25 51 47 N / 81 02 06 W

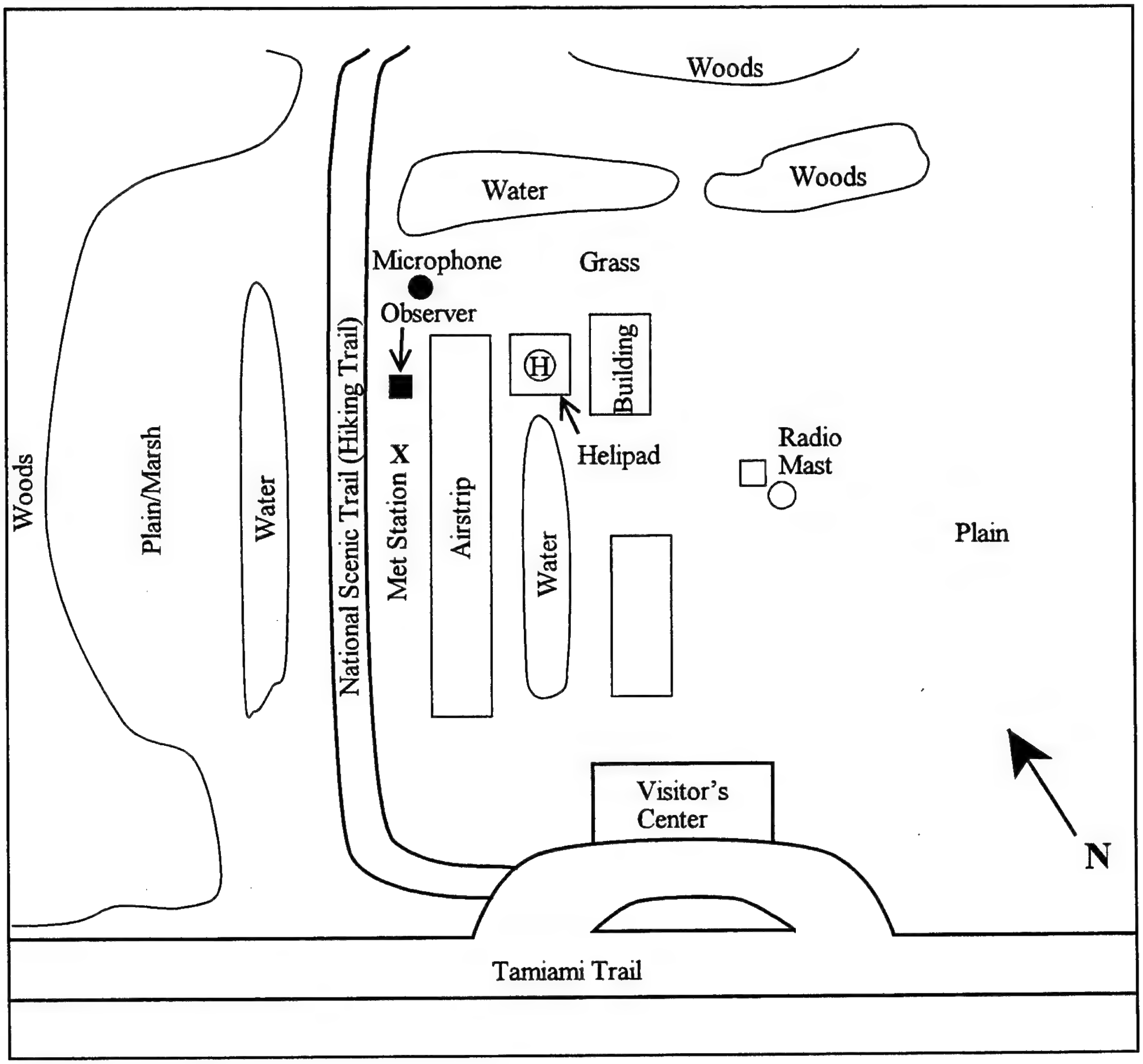


Figure 90. Plan View of National Scenic Trail Site

* Not to scale.

Appendix C:

Acoustic Instrumentation System Reference

C.1 Instrumentation List

A. **B&K Deltatron Microphone System (see Figure 91):**

Model 4155 or 4189 ½-in Electret Condenser Microphone.

Model 2671 Deltatron Preamplifier.

Model WB1372 Deltatron Power Supply.

Custom-fabricated BNC to XLR adapters.

Custom-fabricated 4-conductor 100 ft. (30 m) or 300 ft. (91 m) shielded XLR microphone cables.

B. **Sound Level Meter (SLM):**

LDL Model 820 SLM with Model 827 Preamplifier.

C. **Digital Tape Recorder:**

Sony Model PC208Ax DAT. *or*

Sony Model TCD-D100 DAT.

Ancillary:

NPS Two-Stage Windscreen and Mount including B&K Model UA0237 Foam Windscreen (see Figure 92).

Custom-fabricated nylon ½-in microphone mounting adapter.

B&K Model 4231 Sound Calibrator.

½-in Microphone Simulator (Dummy Microphone).

17 Ah Gel-Cell Battery. *or*

40 Ah Gel-Cell Battery.

Tripod.

C.2 Configuration

A. LDL Model 820 SLM:

1. Calibration - Calibrate using 94 dB SPL signal.

2. Output Gain / Weighting - Ensure that the "AC Output Weighting" is set to "Flat +20." Note: Changing the output gain setting does not affect the SLM indications.

3. Special Calibration - Proper firmware calibration of the LDL Model 820 is dependent on a special calibration procedure using an approved ½-in. microphone and calibrator, or a 0.5 Vrms 1 kHz sine wave. Follow the procedure included in Section B6 of this Appendix entitled "LDL Model 820 SLM Special Calibration." This calibration need not be repeated unless the LDL Model 820 has a power failure during which setup information is lost. Normal calibration of the LDL Model 820 should include capturing a short duration of the calibration signal in SLM mode, and notation of the indicated level.

4. Modified A-Weight for SLM - The A-weight filter in the Volpe Center's Model 820 SLM has been modified to meet Type 1 SLM response using a B&K Model 4155 or 4189 microphone at grazing incidence. Though the random-incidence response of the B&K Model 4155 (and 4189) microphone differs slightly from the grazing-incidence response, the modified A-weight curve still maintains Type 1 SLM performance in a random incidence-type application, as is the case in the current study. (Note that the signal passed to the recorder through the AC Output is *not* weighted.)

5. LDL Model 827 Preamplifier for Impedance Matching - Although the LDL Model 827 preamplifier does not add any gain to the signal, it *must* be connected between the B&K Model WB1372 Power Supply and the LDL Model 820 SLM for impedance matching. Use of the LDL-to-BNC adapter alone will cause the LDL Model 820 input to overload and behave unpredictably.

B. SONY Model PC208Ax DAT Recorder:

1. Mode - Operate at 20 kHz bandwidth (10 kHz is sufficient if necessary). Configure as 2-channel@1X speed, or 4-channel@2X speed. Note: 295 ft. (90 m) tape provides 3 hours recording time at 1X speed.

2. Range - Input voltage range: Calibrate at 1V using 94 dB SPL calibration signal.

C. SONY Model TCD-D100 DAT Recorder:

1. Mode - Operate in Line Input mode at 32 kHz Sample Rate (Half-normal speed). AGC/Limiter switch should be set to "MANUAL". Note: 197 ft. (60 m) tape provides 4 hours recording time at half-normal speed. Use of tapes longer than 60 meters is advised against by the manufacturer.

2. Range - With 94 dB calibration signal applied, adjust input level potentiometer for -6 VU indication. Note: Although the input level potentiometer has a friction-lock feature, care should be exercised to prevent accidental movement of the control.

C.3 Operation

A. Setup:

1. Install NPS Two-Stage windscreen and mount in accordance with Section B7 of this appendix entitled "NPS Two-Stage Windscreen and Mount Instructions."

2. Run microphone cable and connect between B&K Model 2671 Deltatron preamplifier and B&K Model WB1372 Deltatron power supply. Note: Custom-fabricated BNC-to-XLR adapter cables are required at both ends of the microphone cable.

3. Interconnect equipment per Figure 93.

4. Connect power lead for Sony Model PC208Ax to 40 Ah gel-cell battery. Connect power cable to recorder. Turn on all equipment.

5. Set time and date on Sony Model PC208Ax or Sony Model TCD-D100, and LD 820 SLM per Master Clock.

6. Check instrument settings, especially recorder speed, channel configuration and input range.

B. Calibration:

1. Remove fabric cover, rotate windscreen frame assembly out of the way (see Section B7) and remove foam windscreen from microphone.

2. Carefully apply calibrator to microphone.

3. Carefully apply power to calibrator (94 dB setting).

4. Wait at least thirty seconds for system to stabilize.

5. Perform calibration of LDL Model 820.

6. Once the front-end has been calibrated and a steady calibration signal is observed, record the calibration signal on the Sony Model PC208Ax or Sony Model TCD-D100 for one minute. The one-minute duration is required to ensure that the DAT recorder's event ID system does not get "scrambled." A 30-second duration is sufficient when using the PC208Ax's 2X speed mode. (When using the Sony TCD-D100, the display will flash "START-ID" while the event marker is being recorded. Once this stops, it is safe to stop the recording.) Ensure that no gain or weighting is being applied at the front end by checking the setup parameters of the LDL Model 820. A normal calibration will illuminate 4 segments on the Sony Model PC208Ax LCD display. For the TCD-D100, the input level potentiometer should be adjusted for an indication of -6 VU before recording the calibration signal. Once this level has been set, care should be taken to avoid moving the input level control. (Note that this control has a friction-lock feature, which makes accidental movement of the control unlikely.)

7. After recording the calibration signal, turn off the calibrator and remove it from the microphone.

8. Remove the microphone from the B&K Model 2671 Deltatron preamplifier.

9. Attach the ½-in. microphone simulator to the B&K Model 2671.

10. Capture and record one minute of microphone simulator floor (Recording of a 30-second duration should be sufficient when operating the PC208Ax at 2X speed mode). The LDL Model 820 SLM should indicate approximately 16 to 20 dB(A) in the SLM mode.

11. Remove the microphone simulator, and re-install the microphone.

12. Attach the calibrator to the microphone.

13. Apply power to calibrator (94 dB setting).

14. Wait thirty seconds for calibrator signal to stabilize.

15. Perform normal calibration of the LDL Model 820.

16. After calibrating the sound level meter and observing a steady state calibration signal, record the calibration signal on the DAT recorder for one minute (minimum 30 seconds when using the PC208Ax at 2X speed).

17. After recording the calibration signal, turn off the calibrator and remove it from the microphone. Attach the foam windscreen and re-deploy the NPS Two-Stage windscreen (see Section B7).

18. Let the system rest for thirty seconds before starting measurements.

C.4 System Performance Limits

Table 11 presents performance limits for individual components of the acoustic measurement system.

Table 11. System Performance Limits

Component	Mode	Overload Point	Floor (Mic Simulator)
B&K Deltatron Mic System		140 dB SPL	~20 dBA
LD 820 SLM & 827 Preamp		130 dB SPL	~16 to 20 dBA
AC Output	+20 dB Gain	110 dB SPL	~ 16 to 20 dBA
SONY PC208Ax DAT Recorder	1 V Input Range	100 dB SPL	15 dB (linearity floor, FS - 85 dB)
SONY TCD-D100 DAT Recorder	32 kHz Sample Rate (half-speed), Line Input, Manual Gain, 94 dB SPL Cal @ -6 VU	100 dB SPL	15 dB (linearity floor, FS - 85 dB)

C.5 Power Requirements and Considerations

A. Power requirements:

B&K Model WB1372 Deltatron Power Supply: 3 x 9V cells

Typical "life": >> **40 hours**

LDL Model 820: 1 x 9V or external 6 to 12 V (23 mA @ 9V)

Typical "life": 9V - 250 mAh ~ **10 hours**
Duracell 9V: 500 mAh ~ **20 hours**
Radio Shack Ultralife lithium 9V: 1 Ah ~**40 hours**

SONY Model PC208Ax: 11 to 30 V (~1.5 to 2.4 A @ 12V)

Typical "life": **16 to 25 hours** when powered by separate gel-cell battery

SONY Model TCD-D100: 2xAA cells or external 4.3VDC

Typical "life": ~ **5 hours** on Lithium AA cells
~ 2 hours on supplied rechargeable NiMH AA cells
~ 1.5 hours on standard Alkaline AA cells

B&K Model 4231 Calibrator: 4 x AA cells

TAMS Met System: 12 x AA cells or 12V

Typical "life": > **24 hours** on a set of AA cells.

Notebook PC (on inverter): ~1.25 A (Internal battery fully charged)

Typical "life": **16 hours** (2 PCs on 1-40 Ah gel cell battery)

C.6 LDL Model 820 SLM Special Calibration

It is fairly well documented that the LDL Model 820 can provide conflicting sound level readings for the same input signal when comparing readings taken with the unit in calibration mode versus SLM mode. Without proper adjustment, these differences can be as large as several tenths of a decibel. The following procedure was recommended by the manufacturer, LDL, to improve agreement between the calibrated level and the SLM indication on their Model 820 SLM. This is a procedure which should be performed in the laboratory prior to any field measurements. Experience has shown that this procedure generally reduces differences to one tenth of a decibel or less.

1. Apply a 1 kHz sine wave at calibration level through the LDL Model 827 preamplifier (NOTE: LDL's calibration level in their laboratory is equivalent to 0.5 Vrms, however they have indicated that the procedure will work fine with the B&K Model 4155 microphone and a 114 dB SPL calibrator, e.g., the B&K Model 4231).

2. Apply power to the LDL Model 820 and perform a full RESET:

    [SHIFT] [RESET] -> "Reset ALL Data? [Yes]"

    [R/S]

3. Set the LDL Model 820's calibrator level to 225.48 dB (Note: This is a *"Back Door"* into the manufacturer's special calibration procedure):

    [SETUP] [SHIFT] [CAL] -> "CAL Level"...

    [⇨] -> blinking cursor

    [2][2][5][.][4][8][R/S] -> "CAL Level (225.48)"

    [OFF] -> main greeting screen

4. Calibrate the instrument:

[SHIFT] [CAL]	-> "CAL-a"...	If a different letter appears after "CAL", press [SHIFT][CAL] repeatedly until the "CAL-a"... screen appears.
[⇩]	-> "CAL S="...	The unit will go through an extended calibration procedure. The value for 'S' will increment from '1' through '3'. The display will briefly indicate "Done," which will be replaced by "Offset."

NOTE: The above calibration procedure resets the LDL Model 820's detector time-weighting to "Slow" regardless of the current setting. If desired, change Time-weighting as follows:

[SETUP][SLM] -> "Detector [Slow]"

[⇨] (press repeatedly until desired setting appears.)

[R/S]

[OFF]

5. The calibration data may be saved to EEPROM, effectively replacing the factory default as follows:

[SHIFT][STR] -> "STORE EEPROM"

[R/S] -> "Storing SETUP to EEPROM"...

[OFF]

C.7 NPS Two-Stage Windscreen and Mount Instructions

A. Introduction:

The NPS Two-Stage Windscreen and Microphone Mount described herein is a modification of a design originally developed by the acoustic consulting firm of Harris Miller Miller and Hanson, Inc. (HMMH) for the NPS LONOMS system. It performs two primary functions:

1. It minimizes wind-induced noise enough to allow for the measurement of very low-level acoustic data, effectively improving the signal-to-noise ratio of the measured sound.
2. It acts as a mounting system for the microphone and preamplifier.

The unit has standard camera-mount (1/4"-20) screw threads, that can be attached to any standard camera tripod.

B. Components (see Figure 92):

The windscreen frame is comprised of the *Top Disc* (which holds the top ends of the *Ribs* in place via an elastic loop, and is attached to the *Mast* by four *Suspension Cords*), 32 steel wire *Ribs* (which form the shape of the windscreen frame), and the *Sliding Ring* (which, like the *Top Disk*, has an elastic loop to hold the bottom ends of the *Ribs* in place, and which can be fixed into position via three slotted-head setscrews). The *Rib-Spacing Cord* is used to insure uniform spacing between the Ribs when the unit is fully deployed. The Retractable Suspension Fingers help the windscreen frame to form a spherical shape by limiting the vertical travel of the Top Disc.

The Mast was constructed to act as a direct mounting for a B&K 1-in. microphone and preamplifier. It has been adapted to handle a ½-in. microphone and preamplifier by adding a custom-fabricated nylon insert which supports them in the 1-in. cradle.

Not shown is the Fabric Cover, which forms the outer stage of the windscreen. It features a drawstring closure at the bottom, which is used to tighten the fabric around the base of the windscreen frame.

C. Installation Instructions:

1. Set up the tripod for a 5 ft. (1.5 m) microphone height: set the top of the tripod to 33.5 in. (85 cm) above the local ground level.

2. Carefully remove the Two-Stage Mount from its packing container.

3. Attach the Mast to the Tripod. Tighten all Tripod fittings.

4. Raise the *Sliding Ring* to a position just above the *Cable Slot* and tighten the slotted-head setscrews. Remove the foam from the *cable slot* and set aside. Make sure that the *Suspension Cords* are properly aligned by ensuring that the setscrew with the black ring around it is aligned with the vertical groove in the mast.

5. Attach a 6-ft. BNC cable to the B&K Model 2671 preamplifier.

6. Using the attached string, lower the B&K Model JJ2217 ½-in. adapter into the funnel-shaped microphone cradle opening at the top of the mast. Continue lowering the adapter until it appears at the bottom of the mast, visible through the *Cable Slot*.

7. While holding the string at the top of the mast, attach the B&K Model JJ2217 adapter to the front end of the B&K Model 2671 preamplifier. Do not misplace the black plastic cap which protects the threaded end of the Model 2671.

8. Use the string to pull the B&K Model 2671 up through the *Mast* until it appears at the top. While pulling the string, feed the Model 2671 cable in through the *Cable Slot* at the bottom of the *Mast*.

9. Loosen the setscrews on the *Sliding Ring*. Lower it, and rotate the windscreen frame assembly to one side. It may help to slide the *Rib Spacing Cord* downward a bit on the ribs. Gently spread the *Ribs* apart to clear the *Mast, Retractable Suspension Fingers*, etc. Be careful to avoid disengaging the ends of the *Ribs* from the retaining elastics at either end.

10. Remove the B&K Model JJ2217 adapter from the B&K Model 2671 preamplifier.

11. Slide the nylon adapter over the body of the B&K Model 2671. Adjust the position of the preamplifier until the BNC connector is snug against the bottom of the milled step inside the adapter.

12. Gently pull back on the BNC cable to snugly fit the nylon adapter into the Microphone Cradle.

13. Attach the B&K Model 4155 or 4189 Microphone to the Model 2671 preamplifier.

14. Attach the B&K Model UA0237 Foam Windscreen to the B&K Model 4155 or 4189 Microphone.

The remaining steps should be followed after the Calibration Procedure has been completed:

15. Carefully rotate the windscreen frame assembly back into position.

16. Loosen the setscrews on the *Sliding Ring*. Make sure that the *Rib-Spacing Cord* is positioned approximately halfway up the length of each *Rib*.

17. Place the Fabric Cover over the top of the windscreen frame. The "X-seam" of the cover should be located directly over the *Top Disc*.

18. Slowly move the *Sliding Ring* upward until it is even with the lowest of the four *Vertical Alignment Grooves* on the *Mast*. Make sure that the setscrew with the black ring around it is aligned with the long vertical groove on the mast. Tighten the three setscrews.

19. Pull the fabric cover down evenly over the windscreen frame and pull the drawstring tight. Secure it with the string lock.

20. Dress the cable, securing it to the tripod. Tighten all tripod fittings. Replace the foam in the *Cable Slot*.

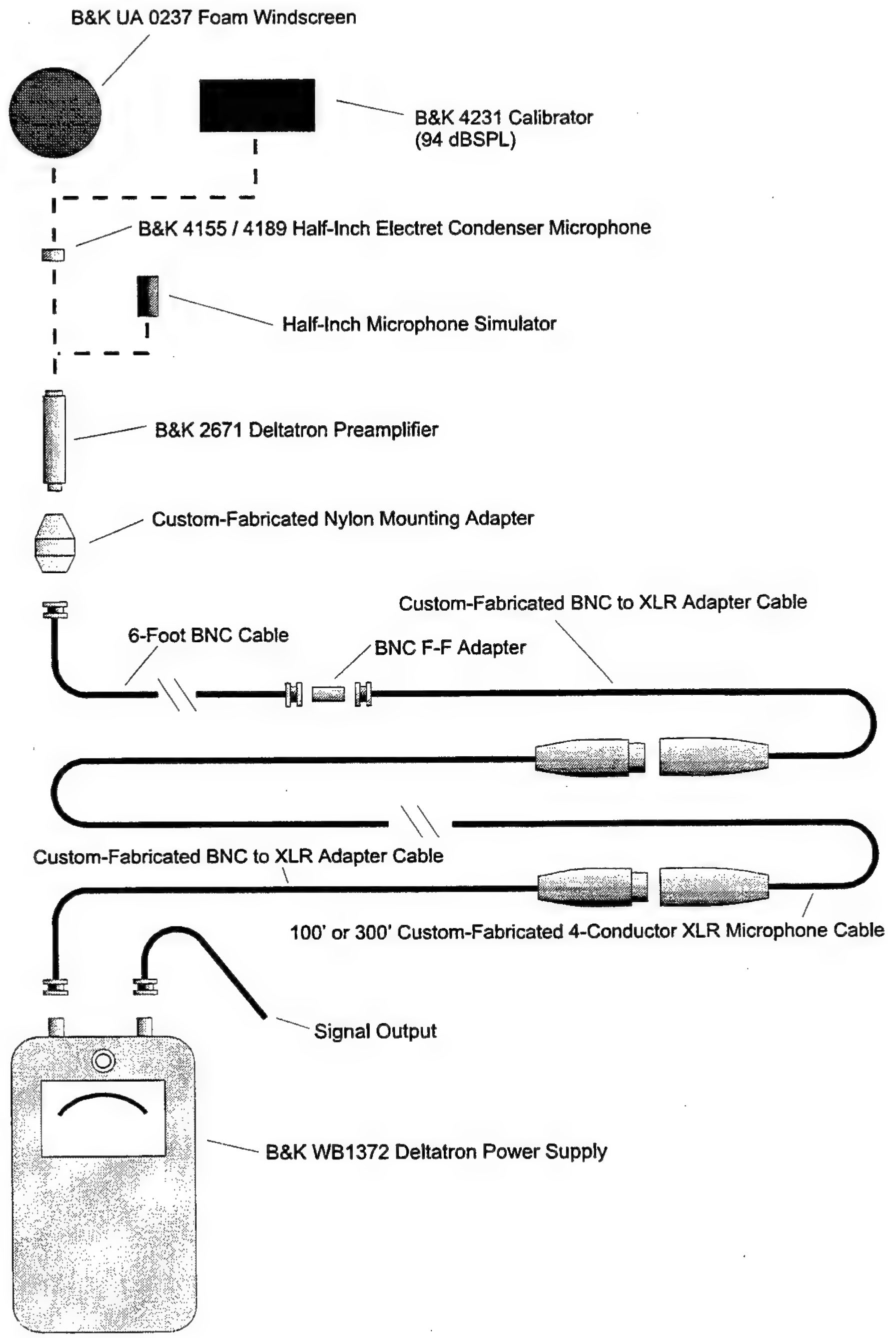


Figure 91. Deltatron Microphone System

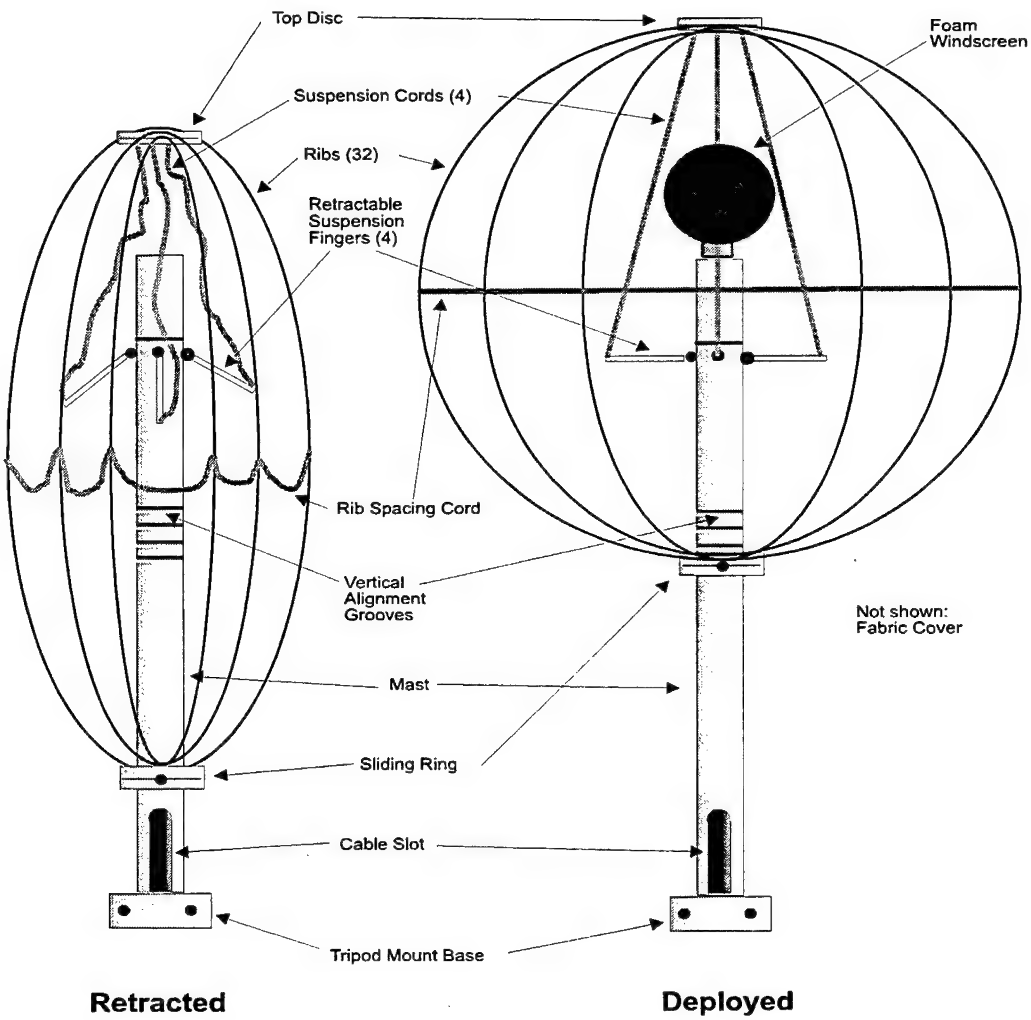


Figure 92. NPS Two-Stage Windscreen and Microphone Mount

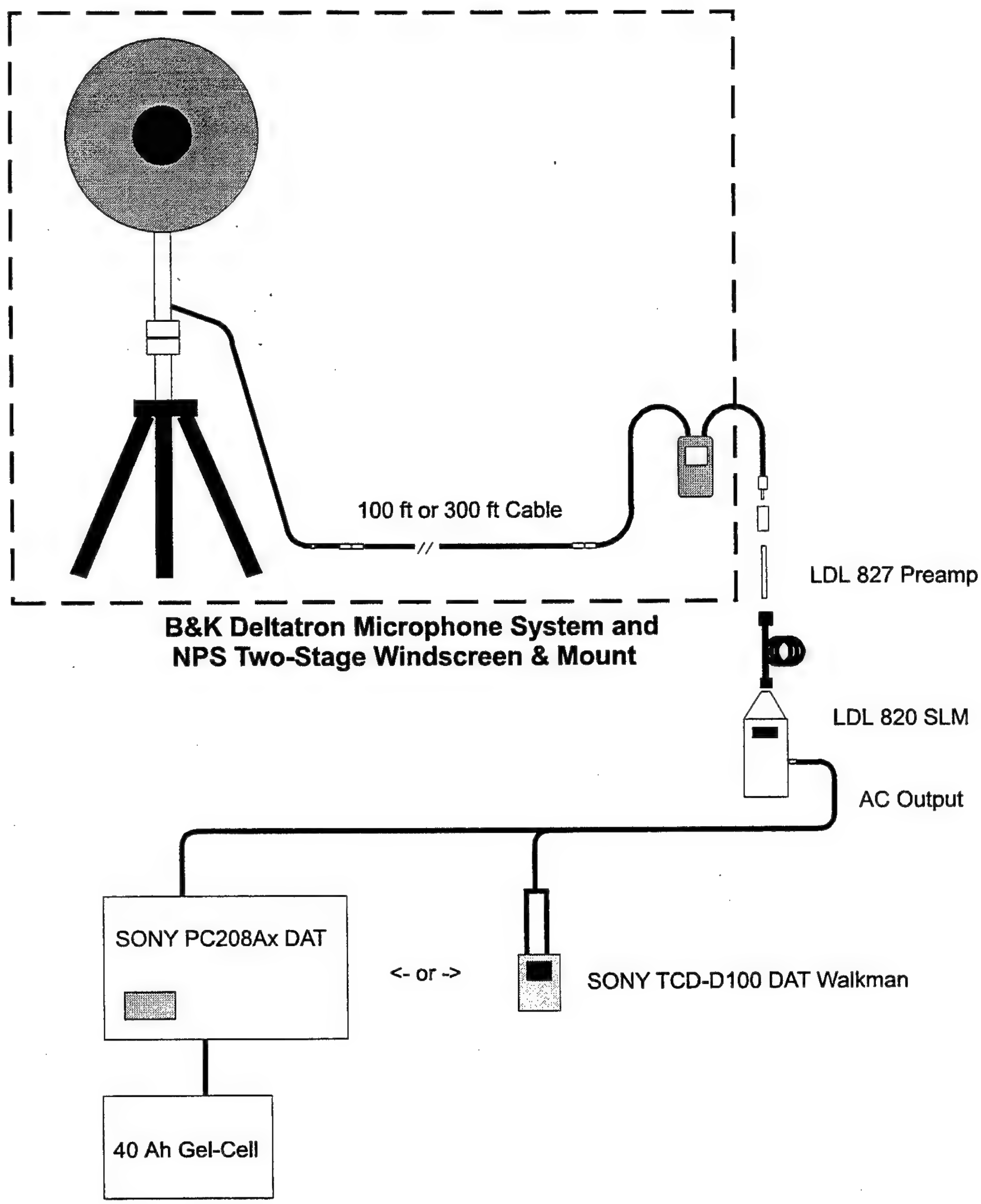


Figure 93. Volpe Measurement & Recording Equipment

Appendix D:

Integrated Noise Model (INM) Enhancements

D.1 Lateral Attenuation

Lateral attenuation in INM has historically been based on the regression equations described in SAE AIR 1751.[20] This Aerospace Information Report (AIR) contains two equations, one for air-to-ground propagation and one for ground-to-ground propagation. Up to and including INM Version 5.2,[21,22] these two field-measurement-based (empirical) equations have been used for computing lateral attenuation for all commercial aircraft within the model. Similar attenuation equations have been used for military aircraft in INM.

Released in 1981, SAE AIR 1751 is based on data which were measured in the 1960s and 1970s. The majority of the aircraft represented in the data set were equipped with low-bypass ratio engines. In addition, the data set is dominated by a single type of jet aircraft, the older 727-100. More generally, for the following two reasons it is recognized by most researchers that the SAE-based lateral attenuation algorithm within INM is the single-biggest ***acoustic*** weakness in the model: (1) the algorithm, which represents a single relationship developed from data dominated by one type of aircraft, is applied to the entire fleet regardless of aircraft type; and (2) the algorithm cannot account for propagation effects over acoustically hard terrain, a major weakness at airports in coastal areas. Consequently, in 1997, the INM development team initiated the task of revising the overground propagation algorithms within the model.

At the most fundamental level, lateral attenuation of aircraft noise comprises two basic physical phenomena: engine installation effects and ground attenuation effects. Engine installation effects, which are implicit in the current SAE AIR 1751 algorithms, may account for sound reflections off of the aircraft wings and fuselage, and sound shielding primarily due to the fuselage. In most cases, these installation effects are thought to be small (and most probably negligible) relative to ground attenuation effects. In fact, in the soon-to-be-released latest version of the Air Force's NOISEMAP computer program for assessing noise impact in the vicinity of military installations, engine installation effects are neglected and lateral attenuation is based solely on ground attenuation effects.

Ground attenuation effects account for the introduction of an impedance boundary, in this case the ground surface, into a given aircraft-to-receiver geometry. The enhancement described herein addresses the ground attenuation effect.

The new approach for computing ground attenuation effects in INM, described in detail herein, is founded in acoustic theory and has undergone rigorous laboratory and field tests. Additional field tests are underway to examine the approach at longer distances, such as would be more typical for aircraft-related analyses.[23,24]

The specific methodology described herein does not include enhancements for undulating terrain, including undulating terrain that blocks the source-to-receiver line-of-sight, i.e., barrier effects. The effects of undulating terrain are currently being evaluated in an effort to reach an acceptable compromise between accuracy and runtime. It is likely these effects will be included in a future version of INM. Regardless, the enhancement was considered an unnecessary complexity for the Homestead SEIS due to the relatively flat nature of the terrain in Southern Florida.

Ultimately, it is the intent of the INM development team to have the general approach peer-reviewed by the SAE A-21 Committee on Airport Noise, and approved for publication as a replacement to SAE AIR 1751. In fact, for the past year the development team has been briefing A-21 on the progress of the work. In general, this effort has been looked upon quite favorably by the committee. At a recent A-21 meeting,[25] members of the development team volunteered to prepare a draft replacement of SAE AIR 1751 based on the general methodology described herein. This general methodology has also been adopted for use in the U.S. Air Force's NOISEMAP computer program. Consequently, for the first time in their history, all the computational methodologies within the INM and NOISEMAP will be consistent, including computations for lateral attenuation.

The remainder of this section overviews the INM's new overground propagation methodology.

D.1.1 Reference Spectral Data

The starting point in any empirical model such as INM is a reference data base. In Version 5.2 and in previous versions the reference data base consisted solely of a set of noise level data expressed as a function of aircraft power and aircraft-to-receiver distance (NPD data). The noise level data exist as either an **exposure-based descriptor, i.e., L_{AE}** or L_{EPN}, or a maximum sound-level descriptor, i.e., L_{ASmx} or L_{PNSmx}. To accurately account for overground propagation effects, frequency-based data at some level of detail are necessary.

Reference 26 presents spectral data for a majority of the civilian aircraft included within INM. Presented in this report for each aircraft is the one-third octave-band spectrum measured at the time of L_{ASmx} and corrected to a distance of 1000 ft. assuming the SAE AIR 1845[27] atmospheric absorption coefficients. Similar data for the military aircraft in INM were provided by the USAF.[28] These data also exist in the form of one-third octave-band spectra measured at the time of L_{ASmx} and corrected to a distance of 1000 ft., assuming the SAE AIR 1845 atmospheric absorption coefficients. In addition, the raw data from previous Volpe Center helicopter noise measurement studies[29-39] were reprocessed to obtain the one-third octave-band spectrum at the same conditions as above. Note that these referenced helicopter noise measurement studies are the source of the NPD data which currently reside in FAA's Heliport Noise Model (HNM) Version 2.2.[40] Although helicopters likely will not be included in INM in the near-term, such data were easily added to the scope of the development and are included in the discussion herein for completeness.

Although the above three references included spectral data for the majority of INM aircraft, there were still 14, mostly older aircraft for which spectral data were not available. (See Table 12 for a summary of the aircraft currently included within INM along with the source of the spectral data associated with each aircraft.) For this reason it was decided that supporting a separate spectrum for each INM aircraft was not feasible. In addition, based on sensitivity tests, it was determined that maintaining separate spectral data for each aircraft would result in a negligible improvement in computational accuracy.

Consequently, the approach of grouping like spectra seemed to offer a logical compromise.

As a result, an exhaustive set of sensitivity tests was conducted to identify like spectra which could be grouped together, resulting in the introduction of a negligible error in overground propagation effects (as a result of the simplification associated with the grouping). Since the resultant "average" spectrum for a grouping is no longer associated with a particular aircraft type it is referred to herein as a ***spectral class***.

For the Homestead analysis, INM contains 57 unique spectral classes. Tables 13, 14, and 15 summarize the aircraft included within each of these 57 classes, for departure (23 classes), approach (27 classes), and level flyover (7 classes, applicable to helicopters only), respectively. As an example, Figure 94 presents the individual spectra grouped into Departure Spectral Class 101. Included within this class are the spectrum for the 727 and 737 with the older JT8D series engines, and the spectrum for the DC10 with the CF6 series and the L1011 with the Rolls Royce series RB2112 engines. Also shown in the figure is a fleet-weighted average spectrum for the example class.

Table 12. Source of Spectral Data for INM Aircraft

AIRCRAFT ID	NOISE ID	SPECTRAL ID	SOURCE OF SPECTRAL DATA
707	JT4A	JT4A	Reference 26
707120	JT3D	JT3D	Reference 26
707320	JT3D	JT3D	Reference 26
707QN	JT3DQ	JT3DQ	Reference 26
720	JT4A	JT4A	Reference 26
720B	JT3D	JT3D	Reference 26
727100	3JT8D	3JT8D	Reference 26
727200	3JT8D	3JT8D	Reference 26
727D15	3JT8D	3JT8D	Reference 26
727D17	3JT8DQ	3JT8DQ	Reference 26
727EM1	3JT8E7	3JT8DQ	Substitution
727EM2	3JT8E5	3JT8DQ	Substitution
727Q15	3JT8DQ	3JT8DQ	Reference 26
727Q7	3JT8DQ	3JT8DQ	Reference 26
727Q9	3JT8DQ	3JT8DQ	Reference 26
727QF	TAY651	3JT8DQ	Substitution
737	2JT8D	2JT8D	Reference 26
737300	CFM563	CFM563	Reference 26
7373B2	CFM563	CFM563	Reference 26
737400	CFM563	CFM563	Reference 26
737500	CFM563	CFM563	Reference 26
737D17	2JT8DQ	2JT8DQ	Reference 26
737QN	2JT8DQ	2JT8DQ	Reference 26
747100	JT9DBD	JT9DBD	Reference 26
74710Q	JT9DFL	JT9DFL	Reference 26
747200	JT9DFL	JT9DFL	Reference 26
74720A	JT9D7Q	JT9DFL	Substitution
74720B	JT9D7Q	JT9DFL	Reference 26
747400	PW4056	JT9DFL	Substitution
747SP	JT9DFL	JT9DFL	Reference 26
757PW	PW2037	RR535E	Substitution
757RR	RR535E	RR535E	Reference 26
767300	2CF680	2CF680	Reference 26
767CF6	2CF680	2CF680	Reference 26
767JT9	2CF680	2CF680	Reference 26

AIRCRAFT ID	NOISE ID	SPECTRAL ID	SOURCE OF SPECTRAL DATA
777200	GE9076	GE9076	Manufacturer
A300	2CF650	2CF650	Reference 26
A310	2CF650	2CF650	Reference 26
A320	CFM565	2CF650	Substitution
A7D	TF41	TF41	Reference 28
BAC111	2JT8D	2JT8D	Reference 26
BAE146	AL502R	AL502R	Reference 26
BAE300	AL502R	AL502R	Reference 26
BEC58P	TSIO52	TSIO52	Reference 26
C130	T56A15	T56A15	Reference 26
CIT3	TF7313	TF7313	Reference 26
CL600	AL502L	AL502L	Reference 26
CL601	CF34	CF34	Reference 26
CNA441	TPE331	TPE331	Reference 26
CNA500	JT15D1	JT15D1	Reference 26
COMJET	CGAJ	CGAJ	Reference 26
COMSEP	CGASEP	CGASEP	Reference 26
CONCRD	OLY593	OLY593	Reference 26
CVR580	501D13	501D13	Reference 26
DC1010	CF66D	CF66D	Reference 26
DC1030	CF66D	CF66D	Reference 26
DC1040	CF66D	CF66D	Reference 26
DC3	2R2800	4R2800	Substitution
DC6	4R2800	4R2800	Reference 26
DC820	JT4A	JT4A	Reference 26
DC850	JT3D	JT3D	Reference 26
DC860	JT3D	JT3D	Reference 26
DC870	CFM562	CFM562	Reference 26
DC8QN	JT3DQ	JT3D	Reference 26
DC910	2JT8D	2JT8D	Reference 26
DC930	2JT8D	2JT8D	Reference 26
DC950	2JT8DQ	2JT8DQ	Reference 26
DC9Q7	2JT8DQ	2JT8DQ	Reference 26
DC9Q9	2JT8DQ	2JT8DQ	Reference 26
DHC6	PT6A27	PT6A27	Reference 26
DHC7	PT6A50	PT6A50	Reference 26
DHC8	PW120	PT6A50	Substitution

AIRCRAFT ID	NOISE ID	SPECTRAL ID	SOURCE OF SPECTRAL DATA
DHC830	PW120	PT6A50	Reference 26
F10062	TAY620	3JT8DQ	Substitution
F10065	TAY650	3JT8DQ	Substitution
F28MK2	RB183	RB183	Reference 26
F28MK4	RB183P	RB183	Substitution
FAL20	CF700	CF700	Reference 26
GASEPF	SEPFP	SEPFP	Reference 26
GASEPV	SEPVP	SEPVP	Reference 26
GIIB	SP5118	SP5118	Reference 26
GIV	TAY620	3JT8DQ	Reference 26
HS748A	RDA532	RDA532	Reference 26
IA1125	TF7313	TF7313	Reference 26
KC135	J57	J57	Reference 26
KC135B	JT3D	JT3D	Reference 26
L1011	RB2112	RB2112	Reference 26
L10115	RB2112	RB2112	Reference 26
L188	T56A7	T56A7	Reference 26
LEAR25	CJ610	CJ610	Reference 26
LEAR35	TF7312	TF7312	Reference 26
MD11GE	2CF68D	2CF680	Substitution
MD11PW	PW4460	2CF680	Substitution
MD81	2JT8D2	2JT8D2	Reference 26
MD82	2JT8D2	2JT8D2	Reference 26
MD83	2JT8D2	2JT8D2	Reference 26
MU3001	JT15D5	JT15D5	Reference 26
SABR80	CF700	CF700	Reference 26
SD330	PT6A45	PT6A45	Reference 26
SF340	CT75	CT75	Reference 26
A109	A109	A109	Reference 37
B206L	B206L	B206L	Reference 36
B212	B212	B212	Reference 37
B222	B222	B222	Reference 29
BO150	BO150	BO150	Reference 37
CH47D	CH47D	CH47D	Reference 35
H500D	H500D	H500D	Reference 31
S61	S61	S61	Reference 37
S65	S65	S65	Reference 37

AIRCRAFT ID	NOISE ID	SPECTRAL ID	SOURCE OF SPECTRAL DATA
S70	S70	S70	Reference 37
S76	S76	S76	Reference 34
SA330	SA330	SA330	Reference 37
SA341	SA341	SA341	Reference 37
SA350	SA350	SA350	Reference 33
SA355	SA355	SA355	Reference 32
SA365	SA365	SA365	Reference 30
A10A	AGE100	AGE100	Reference 28
A3	GE-8	GE-8	Reference 28
A37	J8517A	J8517A	Reference 28
A4C	J52P8A	J52P8A	Reference 28
A5C	GE-10	GE-10	Reference 28
A6A	J52P8B	J52P8B	Reference 28
A7E	TF41A2	TF41A2	Reference 28
AV8A	AV-8A	AV-8A	Reference 28
AV8B	RR-408	RR-408	Reference 28
B1	GE-102	GE-102	Reference 28
B2A	GE-110	GE-110	Reference 28
B52BDE	J57P19	J57P19	Reference 28
B52G	J57P43	J57P43	Reference 28
B52H	B-52H	B-52H	Reference 28
B57E	J57P5	J57P5	Reference 28
BUCCAN	RB168	RB168	Reference 28
C118	RCB17	RCB17	Reference 28
C119L	C-119	C-119	Reference 28
C12	PT6A41	PT6A41	Reference 28
C121	C-121	C-121	Reference 28
C123K	R2800	R2800	Reference 28
C130AD	C-130A	C-130A	Reference 28
C-130E	T56-15	T56-15	Reference 28
C130HP	C-130H	C-130H	Reference 28
C131B	R99W	R99W	Reference 28
C135A	J5759W	J5759W	Reference 28
C135B	J5759	J5759	Reference 28
C137	JT3D3B	JT3D3B	Reference 28
C140	TFE731	TFE731	Reference 28
C141A	TF33P7	TF33P7	Reference 28

AIRCRAFT ID	NOISE ID	SPECTRAL ID	SOURCE OF SPECTRAL DATA
C17	PW-100	PW-100	Reference 28
C18A	JT4111	JT4111	Reference 28
C-20	MK6118	MK6118	Reference 28
C21A	TFE73B	TFE73B	Reference 28
C22	TRS181	TRS181	Reference 28
C23	PT6R65	PT6R65	Reference 28
C5A	TF39GE	TF39GE	Reference 28
C7A	PW123	PW123	Reference 28
C9A	JT8D9	JT8D9	Reference 28
CANBER	AVON	AVON	Reference 28
DOMIN	VIPER	VIPER	Reference 28
E3A	PW100A	PW100A	Reference 28
E4	CF650E	CF650E	Reference 28
E8A	JT3D3	JT3D3	Reference 28
EA6B	P4A	P4A	Reference 28
F-111F	F111F	F111F	Reference 28
F100D	J57P21	J57P21	Reference 28
F101B	J57P55	J57P55	Reference 28
F102	J57P23	J57P23	Reference 28
F104G	GE11A	GE11A	Reference 28
F105D	J75P19	J75P19	Reference 28
F106	J57P17	J57P17	Reference 28
F111AE	TF30P1	TF30P1	Reference 28
F111D	F111D	F111D	Reference 28
F117A	GEF1D2	GEF1D2	Reference 28
F14A	TF30P4	TF30P4	Reference 28
F14B	GE400	GE400	Reference 28
F15A	PW100	PW100	Reference 28
F15E20	PW2205	PW2205	Reference 28
F15E29	PW2295	PW2295	Reference 28
F16A	PW200	PW200	Reference 28
F16GE	GE100	GE100	Reference 28
F16PW0	PW220	PW220	Reference 28
F16PW9	PW229	PW229	Reference 28
F-18	GE404	GE404	Reference 28
F-4C	J79651	J79651	Reference 28
F5AB	GE-13	GE-13	Reference 28

AIRCRAFT ID	NOISE ID	SPECTRAL ID	SOURCE OF SPECTRAL DATA
F5E	GE21B	GE21B	Reference 28
F8	J57P20	J57P20	Reference 28
FB111A	FB111A	FB111A	Reference 28
HARRIE	PEGAS	PEGAS	Reference 28
HAWK	ADOUR	ADOUR	Reference 28
HS748	DART	DART	Reference 28
HUNTER	RA28	RA28	Reference 28
JAGUAR	JAGUA	JAGUA	Reference 28
KC10A	CFG50C	CFG50C	Reference 28
KC-135	F108CF	F108CF	Reference 28
KC97L	R43659	R43659	Reference 28
LIGHTN	302C	302C	Reference 28
MD9025	V2525	V2525	Manufacturer
MD9028	V2525	V2525	Manufacturer
NIMROD	SPEY	SPEY	Reference 28
OV10A	T76	T76	Reference 28
P3A	T56A14	T56A14	Reference 28
PHANTO	PHANTO	PHANTO	Reference 28
PROVOS	VIP11	VIP11	Reference 28
S3A&B	TF346E	TF346E	Reference 28
SR71	JT11D2	JT11D2	Reference 28
T-38A	TJ85	TJ85	Reference 28
T1	JT15DM	JT15DM	Reference 28
T29	T-29	T-29	Reference 28
T-2C	J856E4	J856E4	Reference 28
T3	AEIO54	AEIO54	Reference 28
T33A	J3335	J3335	Reference 28
T34	PT6A25	PT6A25	Reference 28
T37B	J69T25	J69T25	Reference 28
T39A	GEJ85	GEJ85	Reference 28
T41	O320E2	O320E2	Reference 28
T42	IO-550	IO-550	Reference 28
T-43A	T-43A	T-43A	Reference 28
T44	T-44	T-44	Reference 28
T45	F405RR	F405RR	Reference 28
TORNAD	RB1993	RB1993	Reference 28
TR1	J75P1B	J75P1B	Reference 28

AIRCRAFT ID	NOISE ID	SPECTRAL ID	SOURCE OF SPECTRAL DATA
U2	J75P13	J75P13	Reference 28
U21	PT6A20	PT6A20	Reference 28
U4B	540B1A	540B1A	Reference 28
U6	R985	R985	Reference 28
U8F	C480	C480	Reference 28
VC10	CONWY	CONWY	Reference 28
VICTOR	VICTO	VICTO	Reference 28
VULCAN	RROLYM	RROLYM	Reference 28
YC14	CF650D	CF650D	Reference 28
YC15	JT8D17	JT8D17	Reference 28
C130E	T56A7	T56A7	Reference 28
KC135R	CFM56A	CFM56A	Reference 28
F4C	J79	J79	Reference 28

Table 13. Summary of Departure Spectral Classes

AIRCRAFT ID	SPECTRAL ID	SPECTRAL CLASS
737	2JT8D	101
BAC111	2JT8D	101
DC910	2JT8D	101
DC930	2JT8D	101
737D17	2JT8DQ	101
737QN	2JT8DQ	101
DC950	2JT8DQ	101
DC9Q7	2JT8DQ	101
DC9Q9	2JT8DQ	101
727100	3JT8D	101
727200	3JT8D	101
727D15	3JT8D	101
727D17	3JT8DQ	101
727Q15	3JT8DQ	101
727Q7	3JT8DQ	101
727Q9	3JT8DQ	101
727EM2	3JT8E5	101
727EM1	3JT8E7	101
DC1010	CF66D	101
DC1030	CF66D	101
DC1040	CF66D	101
L1011	RB2112	101
L10115	RB2112	101
F10062	TAY620	101
GIV	TAY620	101
F10065	TAY650	101
727QF	TAY651	101
737300	CFM563	102
7373B2	CFM563	102
737400	CFM563	102
737500	CFM563	102
A300	2CF650	103
A310	2CF650	103
767300	2CF680	103
767CF6	2CF680	103

AIRCRAFT ID	SPECTRAL ID	SPECTRAL CLASS
767JT9	2CF680	103
MD11GE	2CF68D	103
A320	CFM565	103
757PW	PW2037	103
MD11PW	PW4460	103
757RR	RR535E	103
MD81	2JT8D2	104
MD82	2JT8D2	104
MD83	2JT8D2	104
F28MK2	RB183	104
F28MK4	RB183P	104
GIIB	SP5118	104
MD9025	V2525	105
MD9028	V2525	105
777200	GE9076	105
DC870	CFM562	106
CONCRD	OLY593	106
707QN	JT3DQ	106
DC8QN	JT3DQ	106
707120	JT3D	107
707320	JT3D	107
720B	JT3D	107
DC850	JT3D	107
DC860	JT3D	107
KC135B	JT3D	107
707	JT4A	107
720	JT4A	107
DC820	JT4A	107
74720A	JT9D7Q	107
74720B	JT9D7Q	107
747100	JT9DBD	107
74710Q	JT9DFL	107
747200	JT9DFL	107
747SP	JT9DFL	107
747400	PW4056	107
BAE146	AL502R	108
BAE300	AL502R	108

AIRCRAFT ID	SPECTRAL ID	SPECTRAL CLASS
COMSEP	CGASEP	109
DHC6	PT6A27	109
SD330	PT6A45	109
GASEPF	SEPFP	109
GASEPV	SEPVP	109
BEC58P	TSIO52	109
DC3	2R2800	110
DC6	4R2800	110
SF340	CT75	110
HS748A	RDA532	110
CVR580	501D13	111
DHC7	PT6A50	111
DHC8	PW120	111
DHC830	PW120	111
L188	T56A7	111
CNA441	TPE331	111
CL600	AL502L	112
CL601	CF34	112
FAL20	CF700	112
SABR80	CF700	112
COMJET	CGAJ	112
LEAR25	CJ610	112
CNA500	JT15D1	112
MU3001	JT15D5	112
LEAR35	TF7312	112
CIT3	TF7313	112
IA1125	TF7313	112
B212	B212	113
BO150	BO150	113
S70	S70	113
B222	B222	114
A109	A109	114
SA350	SA350	114
SA355	SA355	115
S65	S65	115
H500D	H500D	115
SA365	SA365	116

AIRCRAFT ID	SPECTRAL ID	SPECTRAL CLASS
SA341	SA341	116
SA330	SA330	117
S61	S61	117
CH47D	CH47D	118
S76	S76	118
LIGHTN	302C	119
T3	AEIO54	119
C119L	C-119	119
C121	C-121	119
U8F	C480	119
YC14	CF650D	119
KC135R	CFM56A	119
KC-135	F108CF	119
T45	F405RR	119
T42	IO-550	119
KC135	J57	119
SR71	JT11D2	119
T1	JT15DM	119
C-20	MK6118	119
T41	O320E2	119
PHANTO	PHANTO	119
U21	PT6A20	119
T34	PT6A25	119
C12	PT6A41	119
C23	PT6R65	119
C7A	PW123	119
C123K	R2800	119
KC97L	R43659	119
U6	R985	119
C131B	R99W	119
C118	RCB17	119
VULCAN	RROLYM	119
T29	T-29	119
T44	T-44	119
P3A	T56A14	119
OV10A	T76	119
PROVOS	VIP11	119

AIRCRAFT ID	SPECTRAL ID	SPECTRAL CLASS
U4B	540B1A	120
C130AD	C-130A	120
C130HP	C-130H	120
E4	CF650E	120
KC10A	CFG50C	120
VC10	CONWY	120
FB111A	FB111A	120
F16GE	GE100	120
B1	GE-102	120
F-18	GE404	120
C135A	J5759W	120
B57E	J57P5	120
T37B	J69T25	120
C9A	JT8D9	120
F15A	PW100	120
C17	PW-100	120
E3A	PW100A	120
F16A	PW200	120
F16PW0	PW220	120
F15E20	PW2205	120
F16PW9	PW229	120
F15E29	PW2295	120
T-43A	T-43A	120
C-130E	T56-15	120
C130	T56A15	120
C130E	T56A7	120
A7D	TF41	120
A7E	TF41A2	120
C21A	TFE73B	120
C22	TRS181	120
VICTOR	VICTO	120
HAWK	ADOUR	121
CANBER	AVON	121
HS748	DART	121
F111D	F111D	121
F-111F	F111F	121
A5C	GE-10	121

AIRCRAFT ID	SPECTRAL ID	SPECTRAL CLASS
B2A	GE-110	121
F104G	GE11A	121
F117A	GEF1D2	121
T39A	GEJ85	121
T33A	J3335	121
A4C	J52P8A	121
F106	J57P17	121
B52BDE	J57P19	121
F8	J57P20	121
F100D	J57P21	121
F102	J57P23	121
B52G	J57P43	121
F4C	J79	121
F-4C	J79651	121
JAGUAR	JAGUA	121
YC15	JT8D17	121
HARRIE	PEGAS	121
HUNTER	RA28	121
F111AE	TF30P1	121
F14A	TF30P4	121
C141A	TF33P7	121
C140	TFE731	121
A10A	AGE100	122
AV8A	AV-8A	122
B52H	B-52H	122
F5AB	GE-13	122
F5E	GE21B	122
F14B	GE400	122
A3	GE-8	122
A6A	J52P8B	122
C135B	J5759	122
F101B	J57P55	122
U2	J75P13	122
F105D	J75P19	122
TR1	J75P1B	122
A37	J8517A	122
T-2C	J856E4	122

AIRCRAFT ID	SPECTRAL ID	SPECTRAL CLASS
E8A	JT3D3	122
C137	JT3D3B	122
C18A	JT4111	122
EA6B	P4A	122
BUCCAN	RB168	122
TORNAD	RB1993	122
AV8B	RR-408	122
NIMROD	SPEY	122
S3A&B	TF346E	122
C5A	TF39GE	122
T-38A	TJ85	122
DOMIN	VIPER	122
B206L	B206L	123

Table 14. Summary of Approach Spectral Classes

Aircraft ID	Spectral ID	Spectral Class
737	2JT8D	201
BAC111	2JT8D	201
DC910	2JT8D	201
DC930	2JT8D	201
737D17	2JT8DQ	201
737QN	2JT8DQ	201
DC950	2JT8DQ	201
DC9Q7	2JT8DQ	201
DC9Q9	2JT8DQ	201
727100	3JT8D	201
727200	3JT8D	201
727D15	3JT8D	201
727D17	3JT8DQ	201
727Q15	3JT8DQ	201
727Q7	3JT8DQ	201
727Q9	3JT8DQ	201
727EM2	3JT8E5	201
727EM1	3JT8E7	201
F10062	TAY620	201
GIV	TAY620	201
F10065	TAY650	201
727QF	TAY651	201
737300	CFM563	202
7373B2	CFM563	202
737400	CFM563	202
737500	CFM563	202
LEAR25	CJ610	202
A300	2CF650	203
A310	2CF650	203
767300	2CF680	203
767CF6	2CF680	203
767JT9	2CF680	203
MD11GE	2CF68D	203
DC1010	CF66D	203
DC1030	CF66D	203
DC1040	CF66D	203
FAL20	CF700	203

Aircraft ID	Spectral ID	Spectral Class
SABR80	CF700	203
A320	CFM565	203
MU3001	JT15D5	203
757PW	PW2037	203
MD11PW	PW4460	203
L1011	RB2112	203
L10115	RB2112	203
757RR	RR535E	203
MD81	2JT8D2	204
MD82	2JT8D2	204
MD83	2JT8D2	204
777200	GE9076	205
MD9025	V2525	205
MD9028	V2525	205
BAE146	AL502R	206
BAE300	AL502R	206
DC870	CFM562	206
CONCRD	OLY593	206
74720A	JT9D7Q	207
74720B	JT9D7Q	207
74710Q	JT9DFL	207
747200	JT9DFL	207
747SP	JT9DFL	207
747400	PW4056	207
707120	JT3D	208
707320	JT3D	208
720B	JT3D	208
DC850	JT3D	208
DC860	JT3D	208
KC135B	JT3D	208
707QN	JT3DQ	208
DC8QN	JT3DQ	208
707	JT4A	208
720	JT4A	208
DC820	JT4A	208
747100	JT9DBD	209
DHC6	PT6A27	210
CNA441	TPE331	210

Aircraft ID	Spectral ID	Spectral Class
SF340	CT75	211
SD330	PT6A45	211
HS748A	RDA532	212
DC3	2R2800	213
DC6	4R2800	213
DHC7	PT6A50	213
DHC8	PW120	213
DHC830	PW120	213
CVR580	501D13	214
L188	T56A7	214
COMSEP	CGASEP	215
GASEPF	SEPFP	215
GASEPV	SEPVP	215
BEC58P	TSIO52	215
CL600	AL502L	216
CL601	CF34	216
COMJET	CGAJ	216
CNA500	JT15D1	216
F28MK2	RB183	216
F28MK4	RB183P	216
GIIB	SP5118	216
LEAR35	TF7312	216
CIT3	TF7313	216
IA1125	TF7313	216
A109	A109	217
BO150	BO150	217
H500D	H500D	217
S70	S70	218
SA330	SA330	218
B222	B222	218
S61	S61	219
S65	S65	219
S76	S76	219
SA341	SA341	219
SA350	SA350	219
SA355	SA355	220
SA365	SA365	220
CH47D	CH47D	221

Aircraft ID	Spectral ID	Spectral Class
B212	B212	221
HAWK	ADOUR	222
AV8A	AV-8A	222
VC10	CONWY	222
F104G	GE11A	222
A3	GE-8	222
F117A	GEF1D2	222
T39A	GEJ85	222
T33A	J3335	222
A4C	J52P8A	222
C135B	J5759	222
C135A	J5759W	222
B52BDE	J57P19	222
F8	J57P20	222
F100D	J57P21	222
F102	J57P23	222
B52G	J57P43	222
B57E	J57P5	222
F101B	J57P55	222
T37B	J69T25	222
F4C	J79	222
F-4C	J79651	222
A37	J8517A	222
T-2C	J856E4	222
JAGUAR	JAGUA	222
YC15	JT8D17	222
HARRIE	PEGAS	222
BUCCAN	RB168	222
AV8B	RR-408	222
A7D	TF41	222
A7E	TF41A2	222
C140	TFE731	222
T-38A	TJ85	222
VICTOR	VICTO	222
PROVOS	VIP11	222
DOMIN	VIPER	222
LIGHTN	302C	223
U4B	540B1A	223

Aircraft ID	Spectral ID	Spectral Class
CANBER	AVON	223
C121	C-121	223
KC135R	CFM56A	223
KC-135	F108CF	223
F111D	F111D	223
F-111F	F111F	223
FB111A	FB111A	223
F16GE	GE100	223
B1	GE-102	223
F5AB	GE-13	223
F5E	GE21B	223
F-18	GE404	223
A6A	J52P8B	223
KC135	J57	223
F106	J57P17	223
U2	J75P13	223
F105D	J75P19	223
TR1	J75P1B	223
C-20	MK6118	223
EA6B	P4A	223
PHANTO	PHANTO	223
F15A	PW100	223
F16A	PW200	223
F15E20	PW2205	223
F16PW9	PW229	223
F15E29	PW2295	223
HUNTER	RA28	223
TORNAD	RB1993	223
VULCAN	RROLYM	223
NIMROD	SPEY	223
OV10A	T76	223
F111AE	TF30P1	223
C21A	TFE73B	223
T3	AEIO54	224
A10A	AGE100	224
C119L	C-119	224
C130AD	C-130A	224
C130HP	C-130H	224

Aircraft ID	Spectral ID	Spectral Class
U8F	C480	224
YC14	CF650D	224
T45	F405RR	224
A5C	GE-10	224
T42	IO-550	224
U21	PT6A20	224
C12	PT6A41	224
C23	PT6R65	224
C7A	PW123	224
F16PW0	PW220	224
C123K	R2800	224
KC97L	R43659	224
C131B	R99W	224
C118	RCB17	224
T29	T-29	224
T44	T-44	224
C-130E	T56-15	224
P3A	T56A14	224
C130	T56A15	224
C130E	T56A7	224
B52H	B-52H	225
E4	CF650E	225
KC10A	CFG50C	225
HS748	DART	225
B2A	GE-110	225
F14B	GE400	225
T1	JT15DM	225
E8A	JT3D3	225
C137	JT3D3B	225
C18A	JT4111	225
C9A	JT8D9	225
C17	PW-100	225
E3A	PW100A	225
T-43A	T-43A	225
F14A	TF30P4	225
C141A	TF33P7	225
S3A&B	TF346E	225
C5A	TF39GE	225

Aircraft ID	Spectral ID	Spectral Class
C22	TRS181	225
SR71	JT11D2	226
T41	O320E2	226
T34	PT6A25	226
U6	R985	226
B206L	B206L	227

Table 15. Summary of Flyover Spectral Classes

Aircraft ID	Spectral ID	Spectral Class
A109	A109	301
SA355	SA355	301
SA350	SA350	301
BO150	BO150	301
S76	S76	302
SA341	SA341	302
SA365	SA365	302
S61	S61	303
SA330	SA330	303
H500D	H500D	304
B222	B222	304
B212	B212	304
S65	S65	305
S70	S70	305
CH47D	CH47D	306
B206L	B206L	307

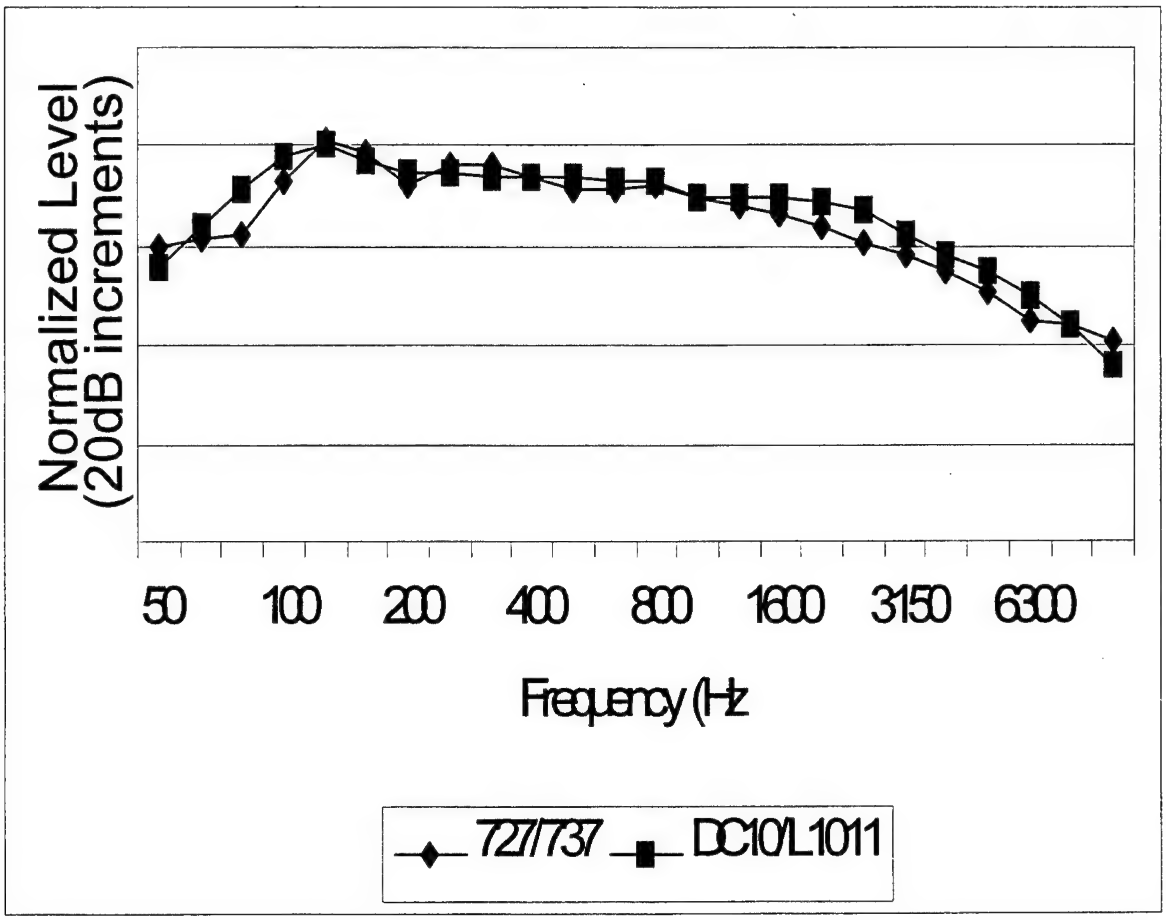


Figure 94. Departure Spectral Class 101

In establishing the average spectrum, a fleet-weighted coefficient was applied based on the national operational data contained within Reference 41. One could argue that the application of the fleet-weighted component may not be appropriate at all airports, and further fleet-weighting will change over time. In fact, the step of applying the fleet-weighted average makes very little difference in the computed ground-effects regression, since aircraft with like spectra are grouped together anyway. However negligible, the fleet-weighted averaging was considered to be most appropriate.

The sensitivity tests cited above indicated that the regressions computed with the fleet-weighted average spectrum as compared with that computed individually using the spectrum for each aircraft in a given class were generally within ± 1 dB of one another at all comparable angles and distances--although in a few instances deviations as large as ±3 dB were observed.

Of course a simple linear averaging process (without the fleet-weighting) would not necessarily improve the error in the computed ground effect. Tables 16, 17, and 18 quantify the deviation in ground effect associated with representing a departure, approach and flyover measured-spectrum with the spectrum for a particular spectral class. In these tables the source-to-receiver distance is 1000 m and the computed reflection angle is one degree.

D.1.2 Ground Effects Model

The ground effects model documented by Tony Embleton, Joe Piercy and Giles Daigle (the EPD Model) of the National Research Council (NRC) in Canada is the foundation for the updated overground propagation effect slated for inclusion in INM. The EPD model is documented extensively in References 42 through 44. Consequently, a brief overview is all that is presented herein. It is important to point out, however, that the EPD model is an assemblage of acoustic research which dates back to the works of Ingard in the 1950s.[45] The derivative work most germane to the discussion presented herein is that of Delany and Bazley, and Chessell.[46,47] It is also important to note that there are other ground effects models which are based on an assemblage of similar and/or

identical research conducted over the years.[48-50] Many of these models will generate identical results to those computed by the EPD model, primarily because they are based on the above-referenced works of Delany, et.al. The EPD model was the primary focus of INM because of the extensive field measurement validation performed in support of its development.

The basic EPD model is defined by the following equation:

$$\frac{p}{p_0} = \underbrace{\left\langle\left(\frac{e^{ik_1 r_1}}{k_1 r_1}\right)\right\rangle}_{\textbf{\textit{Direct Path}}} + \underbrace{\left\langle R_p\left(\frac{e^{ik_1 r_2}}{k_1 r_2}\right) + \frac{(1-R_p)F(\omega)e^{ik_1 r_2}}{k_1 r_2}\right\rangle}_{\textbf{\textit{Ground-Reflected Path}}} \qquad [1]$$

In Equation 1, the first term on the right-hand side of the equality represents the pressure associated with the direct source-to-receiver sound path, and the second and third terms represent the pressure associated with the ground-reflected source-to-receiver sound path.

The plane-wave reflection coefficient, R_p in Equation 1 is computed as follows:

$$R_p = \frac{\left[Z_2 \sin\phi - Z_1\left(1-\left(\frac{k_1^2}{k_2^2}\right)\cos^2\phi\right)^{1/2}\right]}{\left[Z_2 \sin\phi + Z_1\left(1-\left(\frac{k_1^2}{k_2^2}\right)\cos^2\phi\right)^{1/2}\right]} \qquad [2]$$

Table 16. Summary of Deviation in Ground Effect; Distance=1000 m; Departure

Spectral ID	Spectral Class	Deviation at 1°
2JT8D	101	0.088
2JT8DQ	101	0.088
3JT8D	101	0.088
3JT8DQ	101	0.088
CF66D	101	-1.363
RB2112	101	-1.363
CFM563	102	0
2CF650	103	0
2CF680	103	0
RR535E	103	0
2JT8D2	104	0.021
RB183	104	0.079
SP5118	104	0.079
V2525	105	0.986
GE-90	105	-1.001
CFM562	106	0.450
OLY593	106	-0.674
JT3DQ	106	-0.677
JT3D	107	-0.150
JT4A	107	-1.250
JT9DBD	107	-0.858
JT9DFL	107	1.315
AL502R	108	0
CGASEP	109	-0.781
PT6A27	109	-0.060
PT6A45	109	-0.867
SEPFP	109	-0.781
SEPVP	109	-0.781
TSIO52	109	-0.781
2R2800	110	-2.300
CT75	110	0.327
RDA532	110	0.019
501D13	111	-3.911
PT6A50	111	-3.799
T56A7	111	-3.911
TPE331	111	-0.255
AL502L	112	0.865

Spectral ID	Spectral Class	Deviation at 1°
CF34	112	1.622
CF700	112	0.695
CJ610	112	-0.035
JT15D1	112	2.314
JT15D5	112	3.871
TF7312	112	0.836
TF7313	112	3.396
B212	113	0.357
BO150	113	0.943
S70	113	-1.129
B222	114	0.422
A109	114	0.265
SA350	114	0.205
SA355	115	-0.168
S65	115	-0.133
H500D	115	0.507
SA365	116	0.395
SA341	116	-0.193
SA330	117	0.265
S61	117	0.265
CH47D	118	0.752
S76	118	-0.574
302C	119	-1.526
AEIO54	119	1.222
C-119	119	0.592
C-121	119	-0.277
C480	119	1.222
CF650D	119	0.175
CFM56A	119	-0.132
F108CF	119	-0.132
F405RR	119	-0.199
IO-550	119	1.222
J57	119	-0.132
JT11D2	119	0.282
JT15DM	119	0.633
MK6118	119	-0.561
O320E2	119	1.222
PHANTO	119	-1.054

Spectral ID	Spectral Class	Deviation at 1°
PT6A20	119	1.300
PT6A25	119	1.222
PT6A41	119	1.300
PT6R65	119	1.300
PW123	119	-0.462
R2800	119	-0.438
R43659	119	-0.562
R985	119	1.222
R99W	119	-0.438
RCB17	119	-0.438
RROLYM	119	-0.590
T-29	119	-0.615
T-44	119	1.300
T56A14	119	-0.781
T76	119	2.857
VIP11	119	-0.382
540B1A	120	0.581
C-130A	120	-0.537
C-130H	120	-0.537
CF650E	120	0.480
CFG50C	120	-0.026
CONWY	120	0.005
FB111A	120	0.559
GE100	120	0.289
GE-102	120	0.554
GE404	120	-0.150
J5759W	120	0.554
J57P5	120	0.540
J69T25	120	-0.748
JT8D9	120	0.701
PW100	120	0.443
PW-100	120	0.259
PW100A	120	-0.566
PW200	120	-0.332
PW220	120	0.186
PW2205	120	0.443
PW229	120	0.431
PW2295	120	0.443

Spectral ID	Spectral Class	Deviation at 1°
T-43A	120	0.544
T56-15	120	-0.537
T56A15	120	-0.537
T56A7	120	-0.537
TF41	120	0.111
TF41A2	120	0.111
TFE73B	120	-0.463
TRS181	120	0.701
VICTO	120	-0.103
ADOUR	121	0.452
AVON	121	-0.680
DART	121	-0.050
F111D	121	0.690
F111F	121	0.690
GE-10	121	0.331
GE-110	121	-0.123
GE11A	121	0.439
GEF1D2	121	0.204
GEJ85	121	0.519
J3335	121	0.477
J52P8A	121	0.469
J57P17	121	0.759
J57P19	121	0.274
J57P20	121	0.381
J57P21	121	0.381
J57P23	121	0.381
J57P43	121	0.274
J79	121	-0.163
J79651	121	-0.163
JAGUA	121	-0.087
JT8D17	121	0.317
PEGAS	121	-0.181
RA28	121	-0.118
TF30P1	121	0.690
TF30P4	121	-0.049
TF33P7	121	0.270
TFE731	121	0.519
AGE100	122	0.904

Spectral ID	Spectral Class	Deviation at 1°
AV-8A	122	-0.480
B-52H	122	0.594
GE-13	122	-1.512
GE21B	122	-1.512
GE400	122	0.594
GE-8	122	0.799
J52P8B	122	0.502
J5759	122	0.270
J57P55	122	0.798
J75P13	122	0.674
J75P19	122	0.674
J75P1B	122	0.674
J8517A	122	-0.116
J856E4	122	-0.892
JT3D3	122	0.914
JT3D3B	122	0.270
JT4111	122	0.914
P4A	122	0.502
RB168	122	0.360
RB1993	122	0.703
RR-408	122	0.118
SPEY	122	0.909
TF346E	122	-4.944
TF39GE	122	-2.326
TJ85	122	-0.063
VIPER	122	0.020
B206L	123	0

Table 17. Summary of Deviation in Ground Effect; Distance=1000 m; Approach

Spectral ID	Spectral Class	Deviation at 1°
2JT8D	201	0
2JT8DQ	201	0
3JT8D	201	0
3JT8DQ	201	0
CFM563	202	0
CJ610	202	-1.416
CF66D	203	-0.122
RB2112	203	-0.122
2CF650	203	0.023
2CF680	203	0.023
RR535E	203	0.023
CF700	203	-0.907
JT15D5	203	-1.408
2JT8D2	204	0
V2525	205	0.336
GE-90	205	-0.355
CFM562	206	0.813
OLY593	206	2.679
AL502R	206	-0.797
JT9DFL	207	0
JT3D	208	-2.256
JT3DQ	208	1.039
JT4A	208	0.075
JT9DBD	209	0
PT6A27	210	0
TPE331	210	0
PT6A45	211	0.398
CT75	211	0.058
RDA532	212	0
2R2800	213	0
PT6A50	213	-2.660
501D13	214	0
T56A7	214	0
CGASEP	215	0
SEPFP	215	0
SEPVP	215	0
TSIO52	215	0

Spectral ID	Spectral Class	Deviation at 1°
RB183	216	1.526
SP5118	216	1.526
AL502L	216	-1.382
CF34	216	-0.277
JT15D1	216	1.267
TF7312	216	-0.608
TF7313	216	-0.498
A109	217	0.827
BO150	217	0.134
H500D	217	-0.869
S70	218	-0.008
SA330	218	-0.307
B222	218	0.137
S61	219	0.058
S65	219	-0.385
S76	219	1.116
SA341	219	-1.623
SA350	219	0.431
SA355	220	-0.410
SA365	220	-0.431
CH47D	221	-0.413
B212	221	0.422
ADOUR	222	2.586
AV-8A	222	0.756
CONWY	222	1.448
GE11A	222	3.039
GE-8	222	3.012
GEF1D2	222	4.209
GEJ85	222	1.882
J3335	222	2.517
J52P8A	222	2.602
J5759	222	2.590
J5759W	222	2.590
J57P19	222	2.352
J57P20	222	3.012
J57P21	222	3.012
J57P23	222	3.012
J57P43	222	2.352

Spectral ID	Spectral Class	Deviation at 1°
J57P5	222	3.046
J57P55	222	3.012
J69T25	222	3.024
J79	222	2.315
J79651	222	2.315
J8517A	222	2.529
J856E4	222	1.943
JAGUA	222	2.826
JT8D17	222	1.575
PEGAS	222	2.604
RB168	222	3.289
RR-408	222	0.729
TF41	222	2.808
TF41A2	222	2.808
TFE731	222	1.882
TJ85	222	2.481
VICTO	222	3.694
VIP11	222	3.066
VIPER	222	2.166
302C	223	1.102
540B1A	223	3.144
AVON	223	1.378
C-121	223	2.880
CFM56A	223	1.855
F108CF	223	1.885
F111D	223	2.203
F111F	223	2.203
FB111A	223	2.697
GE100	223	0.972
GE-102	223	3.300
GE-13	223	0.331
GE21B	223	0.331
GE404	223	1.460
J52P8B	223	1.394
J57	223	1.855
J57P17	223	1.284
J57P13	223	1.169
J57P19	223	1.176

Spectral ID	Spectral Class	Deviation at 1°
J75P1B	223	1.176
MK6118	223	1.595
P4A	223	1.394
PHANTO	223	2.403
PW100	223	2.092
PW200	223	1.912
PW2205	223	2.092
PW229	223	1.157
PW2295	223	2.092
RA28	223	1.577
RB1993	223	1.529
RROLYM	223	2.258
SPEY	223	1.706
T76	223	4.195
TF30P1	223	2.203
TFE73B	223	0.168
AEIO54	224	1.790
AGE100	224	-4.070
C-119	224	1.479
C-130A	224	-0.896
C-130H	224	-0.896
C480	224	1.790
CF650D	224	0.587
F405RR	224	0.051
GE-10	224	0.191
IO-550	224	1.790
PT6A20	224	0.234
PT6A41	224	0.234
PT6R65	224	0.234
PW123	224	1.085
PW220	224	0.867
R2800	224	-0.592
R43659	224	-0.089
R99W	224	-0.684
RCB17	224	-0.592
T-29	224	-0.592
T-44	224	0.234
T56-15	224	-0.896

Spectral ID	Spectral Class	Deviation at 1°
T56A14	224	0.673
T56A15	224	-0.896
T56A7	224	-0.896
B-52H	225	1.150
CF650E	225	4.011
CFG50C	225	2.873
DART	225	2.582
GE-110	225	4.186
GE400	225	4.437
JT15DM	225	3.431
JT3D3	225	2.669
JT3D3B	225	1.828
JT4111	225	2.669
JT8D9	225	3.369
PW-100	225	2.081
PW100A	225	3.402
T-43A	225	4.381
TF30P4	225	-0.807
TF33P7	225	0.844
TF346E	225	0.359
TF39GE	225	2.976
TRS181	225	3.369
PT6A25	226	-4.121
R985	226	-4.121
O320E2	226	-4.121
JT11D2	226	-1.736
B206L	227	0

Table 18. Summary of Deviation in Ground Effect; Distance=1000 m; Flyover

Spectral ID	Spectral Class	Deviation at 1°
A109	301	0.719
BO150	301	0.310
SA350	301	-0.359
SA355	301	0.993
S76	302	0.997
SA365	302	-0.536
SA341	302	-0.525
SA330	303	-0.953
S61	303	-0.789
B222	304	-1.225
H500D	304	-0.247
B212	304	1.083
S65	305	-0.713
S70	305	0.464
CH47D	306	0
B206L	307	0

In addition, the complex ground wave function, $F(\omega)$ is computed as follows:

$$F(\omega) = 1 + i\pi^{1/2}\omega^{1/2}e^{-\omega} + erfc^{*}\left(-i\sqrt{\omega}\right) \qquad [3]$$

In Equations 1 through 3, p_0 is the pressure near the source at a reference distance of r_0, which is given by $k_1r_1=1$; k_1, which is given by $2\pi fc$, and k_2 (discussed further below) are the wavenumbers of the sound field in air and in the ground surface, respectively; Z_1 and Z_2 are the corresponding specific acoustic impedances of the two media; r_1, r_2, and ϕ are the distance from the source to the receiver, the distance from the geometrical image of the source to the receiver, and the angle between the specularly reflected ray and the ground surface (see Figure 95); and ω is the numerical distance given by the following equation:

$$\omega = i\frac{2k_1r_2}{(1-R_p)^2}\left(\frac{Z_1}{Z_2}\right)^2\left(1-\frac{k_1^2}{k_2^2}\cos^2\phi\right) \qquad [4]$$

Delany and Bazley[46] have developed expressions for the specific acoustic impedance, $Z_2=R_2+iX_2$, and wavenumber $k_2=\alpha_2+i\beta_2$, of the ground surface. These equations are as follows:

$$\begin{aligned}
\frac{R_2}{\rho_1 c_1} &= 1 + 9.08\left(\frac{f}{\sigma}\right)^{-0.75}\\
\frac{X_2}{\rho_1 c_1} &= 11.9\left(\frac{f}{\sigma}\right)^{-0.73}\\
\frac{\alpha_2}{k_1} &= 1 + 10.8\left(\frac{f}{\sigma}\right)^{-0.70}\\
\frac{\beta_2}{k_1} &= 10.3\left(\frac{f}{\sigma}\right)^{-0.59}
\end{aligned} \qquad [5]$$

* A computer implementation of the complementary error function is presented in *Computer Approximations* (1968) by Hart, et.al., as well as in *Numerical Recipes* (1986) by Press, et.al.

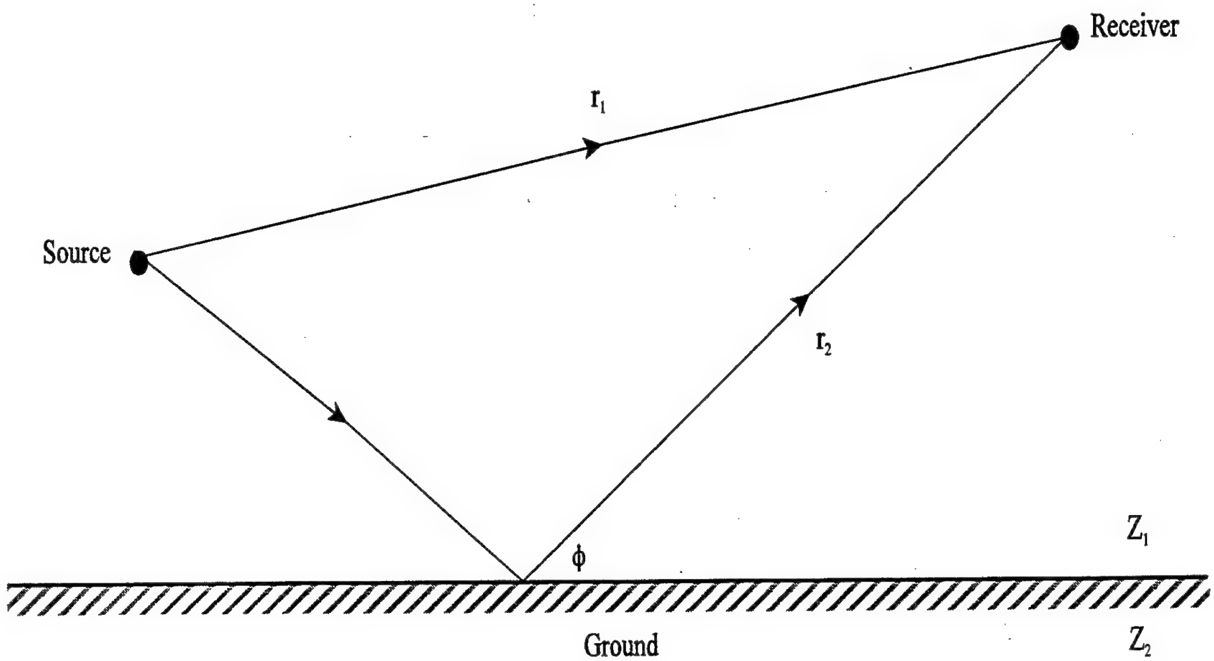


Figure 95. Generic Geometry for EPD Model

In the above Delaney and Bazley equations (identified as Equation 5), f is frequency and σ is the effective flow resistivity of the ground surface expressed in cgs rayls. The effective flow resistivity used herein was either 150 for acoustically soft ground (typical of field grass) or 20,000 for acoustically hard ground (typical of water or pavement). Note: For consistency with the EPD model, the sign in the above equation for the term $X_2/\rho_1 c_1$ was changed as compared with that included in the original Delany and Bazley reference.

Figure 96 presents an example of the acoustically soft ground effect as a function of frequency for a rather simple source-to-receiver geometry (source height=0.31 m; receiver height=1.2 m; and source-to-receiver distance=15.2 m). Similar figures are presented in Reference 42 for various source-to-receiver geometries. To ensure proper implementation of the model, the data presented in these published graphics were all verified separately with the version of the EPD model implemented in support of INM development.

D.1.3 Ground Effects Data Base

Given the library of spectral class data discussed in Section D.1.1, the reference data base for computing overground attenuation effects was established. This data base along with the EPD physical acoustics model discussed in Section D1.2 were used in tandem to develop a comprehensive ground-effect data base. Overviewed in Figure 97, the process used for developing the ground-effects data base is discussed in detail below.

As shown in Figure 97, for a given source to receiver geometry, and ground type, (i.e., acoustically hard or soft, flow resistivity of 20,000 or 150, respectively) the following steps are performed:

(1) the spectrum for a given class (representative of a spectrum at the time of L_{ASmx}, at a distance of 1,000 ft.) was corrected back to the source taking into account the effects of atmospheric absorption over the 1,000 ft. distance, by assuming the SAE AIR 1845 atmospheric absorption coefficients;

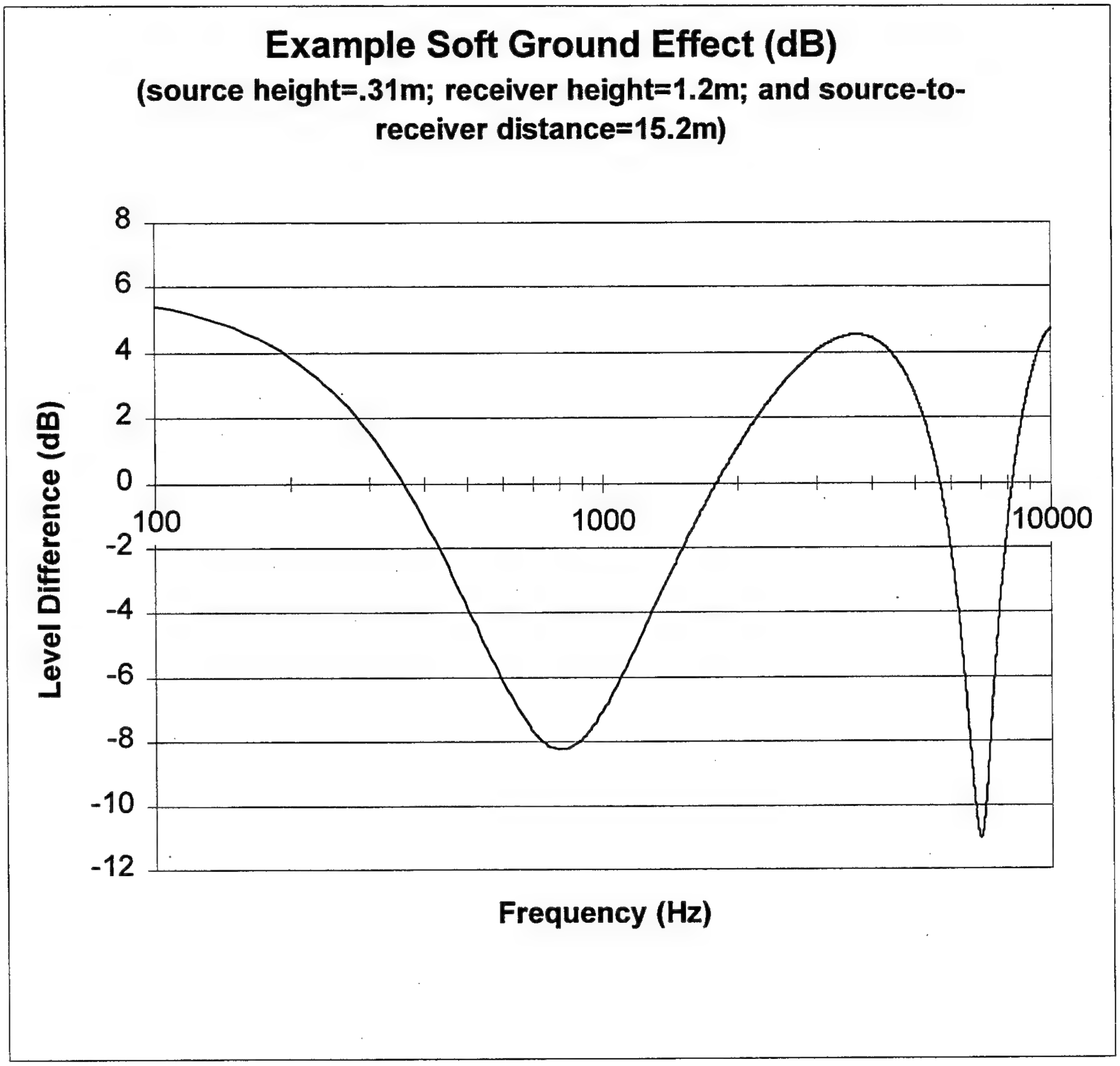


Figure 96. Example Computations for EPD Model

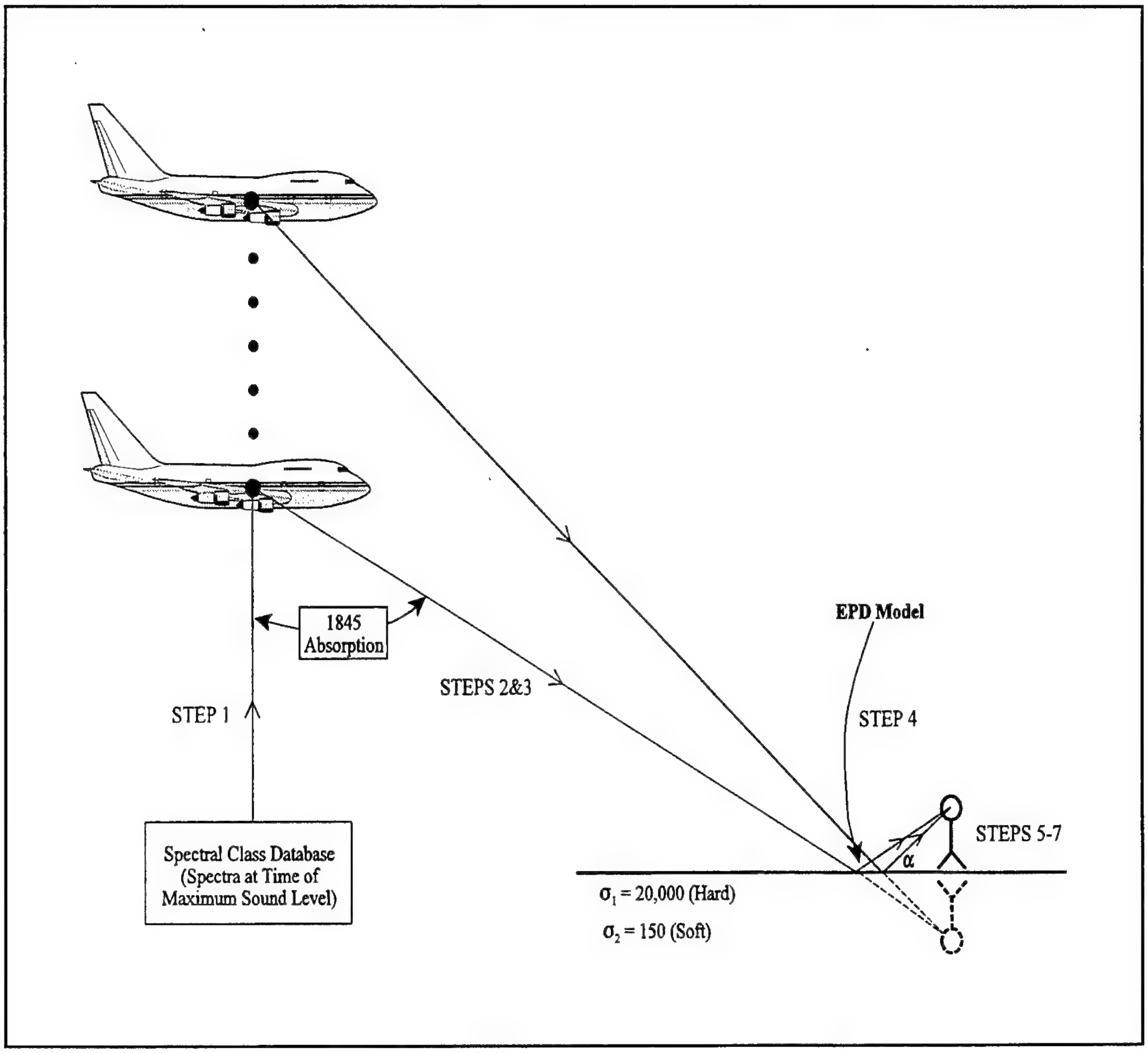


Figure 97. Overview of Process for Developing Ground Effects Data Base

(2) the source-corrected spectrum was then corrected to the point of specular reflection on the ground (assuming a 1.2 m microphone height-- other microphone heights are planned for incorporation into the INM), again taking into account the effects of atmospheric absorption associated with the SAE AIR 1845 atmospheric absorption coefficients;

(3) the reflection-point-corrected spectrum was next adjusted for A-weighting (separate computations based on C-weighting are also planned final incorporation into the INM; and note that for the tone-corrected perceived noise descriptors in INM, e.g., L_{EPN}, computations based on A-weighting will be utilized);

(4) the A-weighted-corrected spectrum was then adjusted for ground effects using the computations of the EPD model. (Namely, the EPD model was run for the specific geometry, and programmed to compute a ground effect for 21 logarithmically spaced frequencies within each one-third-octave band form 50 Hz to 10 kHz, beginning at the Base-10 lower edge of each one-third-octave band, e.g., 891.25 Hz for the 1 kHz one-third-octave band. The ground effect for a given one-third octave band was then computed by simply linearly averaging the 21 ground effect values within a given band.);

(5) the individual SPL values in each band of the reflection-point-corrected spectrum adjusted for A-weighting (Step 3) were than summed on an acoustic energy basis;

(6) the individual SPL values in each band of the A-weight-corrected spectrum adjusted for ground effects (Step 4) were also summed on an acoustic energy basis; and

(7) the decibel value computed in Step 6 was than arithmetically subtracted from the value computed in Step 5. (The difference between these two decibel values represents the ground effect.)

Steps 1 through 7 were repeated for the following source-to-receiver distances: 200, 400, 630, 1000, 2000, 4000 and 6000 meters; and for 33 increments of reflection angle from 0.1 to 89 degrees. The incremental spacing of the reflection angle was selected to most accurately represent the behavior of the ground effect for a given geometry (i.e., the 33 angles selected are as follows: 0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 20, 30, 40, 50, 60, 70, 80, 85 and 89 degrees). In all cases a receiver height of 1.2 m was assumed.

The result of the above process is a ground effects data base, existing as a function of source-to-receiver distance and reflection angle.

D.1.4 Regression Analysis

The next step in the process is to accurately represent the ground effect data base with a set of regression curves (or underlying regression equations). A fairly comprehensive statistical analysis was undertaken to determine the functional form of the regression equations which would best represent the computed data base. The statistical analysis package Statistica[51] was initially used in the analysis, but ultimately the form of the equation was arrived at through other means. Specifically, previous work[52,53] indicated that ground attenuation was best described simply by the two independent variables: reflection angle and source-to-receiver ground distance. Initially, a simple polynomial relationship of the following form was used for the regression:

$$A_{\text{hard or Soft}} = \{X_1+X_2\,(.01d)+(X_3)(.01d)^2\}+ \{X_4+X_5\,(.01d)+(X_6)(.01d)^2\}\{0.1\alpha\}+ \{X_7+X_8\,(.01d)+(X_9)(.01d)^2\}\{0.1\alpha\}^2 \quad \text{(dB)}$$

Where: $A_{\text{hard or Soft}}$ is the attenuation in decibels for a pure acoustically hard or soft geometry;

X_N are empirically-derived regression coefficients;

d is source-to-receiver ground distance (ft); and

α is the reflection angle (degrees).

Using the method of Least Squares, a sample set of regression coefficients was developed for several aircraft. A subsequent error analysis indicated that the initial regression model was inadequate.

Numerical experiments indicated that an increase in the accuracy of approximation could be achieved by adding an exponent to the reflection angle term. In addition, a free-field adjustment term was added to the equation, thus leading to the functional form of the final regression:

$$A_{\text{hard or Soft}} = FF_{ADJ}+\{X_1+X_2\,(.01d)+(X_3)(.01d)^2\}+ \{X_4+X_5\,(.01d)+(X_6)(.01d)^2\}\{0.1\alpha\}^Y+ \{X_7+X_8\,(.01d)+(X_9)(.01d)^2\}\{0.1\alpha\}^2 \quad \text{(dB)}$$

Where: $A_{\text{hard or Soft}}$ is the attenuation in decibels for a pure acoustically hard or soft geometry;

FF_{ADJ} is an adjustment term summarized in Table 19 which effectively corrects the NPD data (to which the ground effect value will be applied), which were measured by a 4 ft. microphone over acoustically soft ground, to a free-field situation;

X_N and Y are empirically-derived regression coefficients;

d is source-to-receiver ground distance (ft.); and

α is the reflection angle (degrees).

Calculation of the final regression coefficients could not be achieved through the traditional method of Least Squares alone. Consequently, a special computer program was developed to assist in the analysis. The program, starting from a small negative value of the coefficient Y, increments/decrements its value by progressively reduced steps. At each step the program computes

respective values for the X_N coefficients using the method of Least Squares. When an absolute minimum in the overall regression error is achieved, the associated computed coefficients are considered final. This approach is effectively an expansion of the traditional Least Squares methodology into the nonlinear domain.

Table 19. Summary of Free-Field Adjustments to NPD data*

Spectral Class	Adjustment (dB)
101	1.14
102	0.53
103	0.80
104	0.74
105	1.06
106	0.64
107	0.70
108	0.80
109	0.92
110	1.22
111	1.30
112	0.38
113	1.83
114	0.88
115	0.84
116	0.25
117	0.54
118	0.56
119	1.08
120	0.61
121	0.38
122	0.35
123	2.20
201	0.91
202	0.53
203	0.57
204	0.75
205	0.79
206	0.51

Spectral Class	Adjustment (dB)
207	0.74
208	0.59
209	0.39
210	1.21
211	1.26
212	0.99
213	1.74
214	0.67
215	1.34
216	0.77
217	0.96
218	2.26
219	1.65
220	1.79
221	1.87
222	0.48
223	0.77
224	1.20
225	0.53
226	1.44
227	1.30
301	1.21
302	0.52
303	0.47
304	1.49
304	0.79
306	1.14
307	1.70

* The adjustment to free-field conditions for each spectral class was arrived at by arithmetically averaging the EPD-based attenuation values at 30, 40, 50, 60, 70, and 80 degrees for source-to-receiver distances of 200, 400, 630, and 1000 m.

To further improve accuracy of the computed regression equations, the initial range of reflection angles from 0.1 to 85 degrees was segmented into eleven sub-segments selected as follows: 0.1 to 0.4 degrees; 0.41 to 0.7 degrees; 0.71 to 1.0 degrees; 1.1 to 3 degrees; 3.1 to 4 degrees; 4.1 to 6 degrees; 6.1 to 8 degrees; 8.1 to 10 degrees; 10.1 to 15 degrees; 15.1 to 40 degrees; and 40.1 to 85 degrees. The final regression coefficients are summarized in Table 20.

In subsegmenting the regression there was some concern about introducing discontinuities at the junction of the subsegments. Consequently, an analysis of discontinuities was performed at the junction of these subsegments for distances of 200, 400, 630, 1000, 2000, 4000 and 6000 meters. Initially, the analysis indicated at the majority (approximately 91 percent) of the junctions the discontinuities were less than 0.1 dB, at approximately 8 percent of the junctions the discontinuity was less than 0.3 dB; and for the remaining one percent the discontinuity was as large as 1 dB. For discontinuities falling into the later category, the ground effect data at the associated combination of distance and angle were replaced by a new value which was computed through interpolation of ground effect values from the closest combination of distance and angle. Following interpolation, the regression coefficients were then recomputed. The final result was that all discontinuities were less than 0.3 dB, with some 92 percent less than 0.1 dB.

As an example, Figures 98 and 99 present, respectively, for departure spectral class 101 and a distance of 1000 m, the original data in the ground effects data base along with the computed regression for propagation over acoustically soft and hard ground. These comparisons can be considered typical.

D.1.5 Implementation of Regression Equations

Before the regression equations could be included within the INM, several practical constraints had to be incorporated into the design. First, an upper limit of 20 decibels of attenuation was placed on the equations. It is likely that this limit will only be triggered at large source-to-receiver distances when the aircraft is on the ground, and the ground is acoustically soft. The 20 dB is considered a

Table 20. Summary of Regression Coefficients

Regression Coefficients for Spectral Class 101 - σ=150										
	X_1	X_2	X_3	X_4	X_5	X6	X_7	X_8	X_9	Y
α<0.4	-1.23	-0.13	0.00	-6.80	-0.01	0.00	1639.08	19.29	-0.12	-0.20
0.4≤α<0.7	-11.54	0.14	0.00	-0.25	-0.03	0.00	1055.37	-15.26	0.06	-0.60
0.7≤α<1.0	71.27	1.18	-0.01	-60.03	-0.96	0.01	-66.12	-6.44	0.04	-0.10
1.0≤α<3.0	33.07	-0.02	0.00	-23.87	-0.05	0.00	-28.71	0.28	0.00	-0.20
3.0≤α<4.0	0.44	-0.04	0.00	-0.37	-0.02	0.00	1.94	0.19	0.00	-0.30
4.0≤α<6.0	3.98	0.32	0.00	-2.66	-0.29	0.00	-3.24	-0.04	0.00	-0.20
6.0≤α<8.0	-1.06	0.10	0.00	1.12	-0.10	0.00	-1.04	-0.01	0.00	-0.30
8.0≤α<10	-16.55	0.12	0.00	15.82	-0.14	0.00	-0.11	0.00	0.00	-0.08
10≤α<15	-13.01	-0.21	0.00	11.47	0.19	0.00	0.68	0.01	0.00	-0.17
15≤α<40	0.28	0.01	0.00	-2.87	-0.03	0.00	-0.05	0.00	0.00	-2.70
40≤α<85	-7.25	0.30	0.00	10.42	-0.48	0.01	0.04	0.00	0.00	-0.40

Regression Coefficients for Spectral Class 102 - σ=150										
	X_1	X_2	X_3	X_4	X_5	X6	X_7	X_8	X_9	Y
α<0.4	0.83	-0.04	0.00	-8.69	-0.02	0.00	2644.97	-10.30	0.03	-0.20
0.4≤α<0.7	-3.68	0.01	0.00	-1.31	-0.01	0.00	786.91	-9.67	0.04	-0.60
0.7≤α<1.0	22.78	-0.15	0.00	-12.90	0.01	0.00	-69.15	2.16	-0.01	-0.30
1.0≤α<3.0	16.03	0.09	0.00	-9.83	-0.09	0.00	-8.92	-0.02	0.00	-0.30
3.0≤α<4.0	-1.46	-0.05	0.00	1.71	-0.01	0.00	4.31	0.23	0.00	-0.20
4.0≤α<6.0	2.85	0.16	0.00	-0.75	-0.13	0.00	-2.99	-0.03	0.00	-0.40
6.0≤α<8.0	2.29	0.09	0.00	-1.09	-0.09	0.00	-0.83	0.00	0.00	-0.10
8.0≤α<10	-17.94	-0.16	0.00	18.22	0.13	0.00	-0.06	0.03	0.00	-0.10
10≤α<15	-13.44	0.53	0.00	12.99	-0.51	0.00	0.67	-0.03	0.00	-0.20
15≤α<40	1.85	-0.07	0.00	-2.03	0.08	0.00	-0.02	0.00	0.00	-0.20
40≤α<85	-14.02	-0.58	0.00	20.09	0.84	-0.01	0.05	0.00	0.00	-0.30

Regression Coefficients for Spectral Class 103 - σ=150										
	X_1	X_2	X_3	X_4	X_5	X6	X_7	X_8	X_9	Y
α<0.4	11.99	-0.35	0.00	-12.16	0.09	0.00	1387.01	23.63	-0.12	-0.20
0.4≤α<0.7	60.23	-0.75	0.00	-35.62	0.30	0.00	-770.38	19.71	-0.08	-0.20
0.7≤α<1.0	81.57	3.47	-0.02	-65.70	-2.67	0.02	15.24	-25.32	0.15	-0.10
1.0≤α<3.0	34.87	-0.05	0.00	-22.40	-0.07	0.00	-50.95	0.58	0.00	-0.20
3.0≤α<4.0	-8.38	-0.17	0.00	10.00	0.03	0.00	-12.85	0.55	0.00	-0.10
4.0≤α<6.0	-16.26	0.41	0.00	10.67	-0.29	0.00	8.68	-0.22	0.00	-0.40
6.0≤α<8.0	12.68	-0.18	0.00	-9.69	0.11	0.00	-3.95	0.05	0.00	-0.30
8.0≤α<10	-69.15	-0.39	0.01	65.32	0.34	-0.01	3.33	0.04	0.00	-0.10
10≤α<15	-3.81	-0.03	0.00	2.99	0.01	0.00	0.31	0.01	0.00	-0.30
15≤α<40	5.79	0.45	0.00	-6.75	-0.49	0.00	-0.07	0.00	0.00	-0.20
40≤α<85	-1.57	0.03	0.00	542.40	-2.65	0.20	0.02	0.00	0.00	-4.80

Regression Coefficients for Spectral Class 104 - σ=150										
	X_1	X_2	X_3	X_4	X_5	X6	X_7	X_8	X_9	Y
α<0.4	12.48	0.03	0.00	-16.22	-0.06	0.00	1647.53	-1.97	-0.01	-0.17
0.4≤α<0.7	25.30	-0.47	0.00	-10.20	0.10	0.00	-787.45	23.17	-0.10	-0.40
0.7≤α<1.0	75.51	3.64	-0.02	-64.34	-2.74	0.02	102.09	-27.09	0.16	-0.10
1.0≤α<3.0	40.80	-0.16	0.00	-28.40	0.04	0.00	-38.93	0.47	0.00	-0.20
3.0≤α<4.0	-2.68	-0.19	0.00	2.83	0.07	0.00	2.14	0.34	0.00	-0.20
4.0≤α<6.0	-1.09	0.19	0.00	1.74	-0.16	0.00	-2.24	-0.05	0.00	-0.40
6.0≤α<8.0	-7.04	0.14	0.00	5.99	-0.13	0.00	0.81	-0.02	0.00	-0.30
8.0≤α<10	-13.13	-0.01	0.00	11.77	-0.01	0.00	0.92	0.02	0.00	-0.24
10≤α<15	-7.22	0.21	0.00	6.07	-0.21	0.00	0.70	0.00	0.00	-0.20
15≤α<40	0.10	0.01	0.00	-0.98	-0.05	0.00	-0.02	0.00	0.00	-4.80
40≤α<85	-4.82	0.09	0.00	13.87	-0.24	0.01	0.04	0.00	0.00	-0.90

Regression Coefficients for Spectral Class 105 - σ=150										
	X_1	X_2	X_3	X_4	X_5	X6	X_7	X_8	X_9	Y
α<0.4	8.09	-0.33	0.00	-10.50	0.08	0.00	1326.75	27.12	-0.13	-0.20
0.4≤α<0.7	35.22	-0.25	0.00	-23.48	0.05	0.00	-134.23	6.36	-0.03	-0.20
0.7≤α<1.0	40.72	-0.08	0.00	-26.95	-0.03	0.00	-46.58	-0.99	0.01	-0.20
1.0≤α<3.0	33.43	-0.03	0.00	-22.37	-0.07	0.00	-45.87	0.57	0.00	-0.20
3.0≤α<4.0	4.01	-0.04	0.00	-1.64	-0.04	0.00	-9.43	0.31	0.00	-0.30
4.0≤α<6.0	-8.95	0.31	0.00	6.07	-0.23	0.00	3.34	-0.13	0.00	-0.40
6.0≤α<8.0	5.27	-0.04	0.00	-4.17	0.01	0.00	-1.98	0.02	0.00	-0.30
8.0≤α<10	-30.44	-0.25	0.00	28.69	0.21	0.00	0.99	0.03	0.00	-0.10
10≤α<15	-5.34	-0.01	0.00	4.17	0.00	0.00	0.40	0.01	0.00	-0.30
15≤α<40	-0.52	0.00	0.00	-1.75	-0.04	0.00	0.00	0.00	0.00	-4.80
40≤α<85	-21.29	0.12	0.00	25.94	-0.13	0.00	0.07	0.00	0.00	-0.20

Regression Coefficients for Spectral Class 106 - σ=150										
	X_1	X_2	X_3	X_4	X_5	X6	X_7	X_8	X_9	Y
α<0.4	-3.76	-0.09	0.00	-4.37	-0.01	0.00	2866.95	-12.47	0.03	-0.30
0.4≤α<0.7	-2.58	-0.03	0.00	-1.34	-0.01	0.00	735.63	-9.05	0.03	-0.60
0.7≤α<1.0	42.14	-0.14	0.00	-27.59	0.00	0.00	-123.68	1.05	0.00	-0.20
1.0≤α<3.0	10.08	0.04	0.00	-5.12	-0.07	0.00	-13.14	0.14	0.00	-0.40
3.0≤α<4.0	1.44	-0.03	0.00	-0.44	-0.03	0.00	-2.29	0.27	0.00	-0.30
4.0≤α<6.0	-1.58	0.13	0.00	1.14	-0.09	0.00	0.63	-0.06	0.00	-0.60
6.0≤α<8.0	4.67	-0.01	0.00	-3.44	-0.01	0.00	-1.30	0.02	0.00	-0.30
8.0≤α<10	0.23	-0.46	0.00	-0.06	0.39	0.00	-0.03	0.07	0.00	-0.23
10≤α<15	7.53	0.28	0.00	-7.06	-0.28	0.00	-0.33	-0.01	0.00	-0.17
15≤α<40	-0.28	0.01	0.00	2.74	0.01	0.00	0.02	0.00	0.00	-4.80
40≤α<85	-24.88	-0.04	0.00	31.51	0.08	0.00	0.07	0.00	0.00	-0.20

Regression Coefficients for Spectral Class 107 - σ=150										
	X_1	X_2	X_3	X_4	X_5	X6	X_7	X_8	X_9	Y
α<0.4	7.69	-0.34	0.00	-6.44	0.05	0.00	1089.11	28.37	-0.13	-0.30
0.4≤α<0.7	79.80	-1.17	0.00	-44.60	0.50	0.00	-1371.21	32.91	-0.14	-0.20
0.7≤α<1.0	76.80	4.30	-0.03	-61.29	-3.29	0.02	81.25	-31.72	0.19	-0.10
1.0≤α<3.0	21.77	-0.20	0.00	-8.22	0.01	0.00	-85.83	1.49	-0.01	-0.40
3.0≤α<4.0	-3.03	-0.04	0.00	3.07	-0.04	0.00	-1.78	0.32	0.00	-0.20
4.0≤α<6.0	56.39	-0.96	0.00	-34.51	0.57	0.00	-38.75	0.69	0.00	-0.40
6.0≤α<8.0	-40.72	0.73	0.00	29.06	-0.53	0.00	14.30	-0.26	0.00	-0.40
8.0≤α<10	-57.02	1.07	0.00	49.02	-0.93	0.00	7.60	-0.14	0.00	-0.30
10≤α<15	6.49	-0.11	0.00	-6.32	0.09	0.00	-0.59	0.02	0.00	-0.30
15≤α<40	3.24	0.11	0.00	-3.89	-0.12	0.00	-0.04	0.00	0.00	-0.20
40≤α<85	-17.81	0.15	0.00	21.82	-0.15	0.00	0.05	0.00	0.00	-0.20

Regression Coefficients for Spectral Class 108 - σ=150										
	X_1	X_2	X_3	X_4	X_5	X6	X_7	X_8	X_9	Y
α<0.4	16.49	-0.49	0.00	-13.83	0.15	0.00	1691.07	16.99	-0.07	-0.20
0.4≤α<0.7	-7.90	0.11	0.00	-0.19	-0.04	0.00	1314.12	-22.23	0.09	-0.60
0.7≤α<1.0	77.60	2.61	-0.02	-60.44	-2.08	0.01	-179.45	-14.80	0.10	-0.10
1.0≤α<3.0	6.74	0.27	0.00	-3.60	-0.21	0.00	-1.61	-0.23	0.00	-0.30
3.0≤α<4.0	-2.98	-0.07	0.00	3.49	-0.01	0.00	-0.36	0.31	0.00	-0.20
4.0≤α<6.0	0.04	0.13	0.00	0.99	-0.10	0.00	-2.87	-0.03	0.00	-0.50
6.0≤α<8.0	2.53	-0.02	0.00	-1.32	0.00	0.00	-1.93	0.02	0.00	-0.30
8.0≤α<10	-55.12	-0.34	0.01	52.24	0.31	-0.01	2.43	0.03	0.00	-0.10
10≤α<15	-11.57	0.33	0.00	10.35	-0.31	0.00	0.77	-0.02	0.00	-0.20
15≤α<40	3.77	0.00	0.00	-4.36	0.00	0.00	-0.07	0.00	0.00	-0.20
40≤α<85	-20.82	-0.01	0.00	25.27	0.00	0.01	0.07	0.00	0.00	-0.20

Regression Coefficients for Spectral Class 109 - σ=150										
	X_1	X_2	X_3	X_4	X_5	X6	X_7	X_8	X_9	Y
$\alpha<0.4$	-18.57	-0.14	0.00	3.32	-0.04	0.00	801.52	42.40	-0.20	-0.20
$0.4\le\alpha<0.7$	-59.24	1.25	0.00	16.87	-0.50	0.00	2451.14	-45.03	0.17	-0.30
$0.7\le\alpha<1.0$	44.41	-1.92	0.01	-40.64	1.32	-0.01	-196.48	20.13	-0.11	-0.10
$1.0\le\alpha<3.0$	-0.20	0.08	0.00	-2.19	-0.03	0.00	20.88	-0.30	0.00	-0.60
$3.0\le\alpha<4.0$	-1.72	-0.26	0.00	-2.08	0.18	0.00	16.82	0.19	0.00	-0.20
$4.0\le\alpha<6.0$	21.83	0.13	0.00	-19.00	-0.11	0.00	-3.14	-0.05	0.00	-0.20
$6.0\le\alpha<8.0$	11.20	0.00	0.00	-9.24	-0.01	0.00	-2.18	0.00	0.00	-0.30
$8.0\le\alpha<10$	11.00	-0.13	0.00	-9.29	0.10	0.00	-1.80	0.02	0.00	-0.30
$10\le\alpha<15$	4.22	0.21	0.00	-3.61	-0.21	0.00	-0.67	-0.01	0.00	-0.20
$15\le\alpha<40$	-1.67	-0.01	0.00	3.68	0.00	0.00	0.19	0.00	0.00	-4.80
$40\le\alpha<85$	-28.30	1.14	0.00	43.03	-1.59	0.00	0.07	-0.01	0.00	-0.30

Regression Coefficients for Spectral Class 110 - σ=150										
	X_1	X_2	X_3	X_4	X_5	X6	X_7	X_8	X_9	Y
$\alpha<0.4$	-19.30	-0.15	0.00	2.56	-0.02	0.00	2040.00	17.80	-0.09	-0.20
$0.4\le\alpha<0.7$	-53.20	1.15	0.00	14.30	-0.47	0.00	2790.00	-53.90	0.21	-0.30
$0.7\le\alpha<1.0$	62.00	0.82	0.00	-52.50	-0.75	0.00	-204.00	-0.80	0.01	-0.10
$1.0\le\alpha<3.0$	15.80	0.28	0.00	-13.80	-0.25	0.00	-13.00	0.00	0.00	-0.20
$3.0\le\alpha<4.0$	-4.91	-0.07	0.00	1.29	0.01	0.00	6.01	0.22	0.00	-0.10
$4.0\le\alpha<6.0$	5.16	0.30	0.00	-6.19	-0.26	0.00	-1.56	-0.06	0.00	-0.20
$6.0\le\alpha<8.0$	2.37	0.02	0.00	-3.41	-0.02	0.00	-1.22	-0.01	0.00	-0.40
$8.0\le\alpha<10$	-8.49	0.03	0.00	5.74	-0.05	0.00	0.53	0.00	0.00	-0.20
$10\le\alpha<15$	2.72	-1.58	0.01	-5.46	1.49	-0.01	0.42	0.09	0.00	-0.18
$15\le\alpha<40$	5.91	0.05	0.00	-10.20	-0.09	0.00	-0.20	0.00	0.00	-1.00
$40\le\alpha<85$	-8.28	0.50	-0.01	13.60	-0.76	0.01	0.03	0.00	0.00	-0.40

Regression Coefficients for Spectral Class 111 - σ=150										
	X_1	X_2	X_3	X_4	X_5	X6	X_7	X_8	X_9	Y
$\alpha<0.4$	-2.95	-0.58	0.00	-0.78	0.14	0.00	-1140.00	66.90	-0.23	-0.20
$0.4\le\alpha<0.7$	-83.50	1.74	-0.01	38.60	-0.99	0.00	2200.00	-40.30	0.15	-0.20
$0.7\le\alpha<1.0$	18.30	-2.19	0.02	-18.30	1.48	-0.01	-231.00	24.40	-0.14	-0.10
$1.0\le\alpha<3.0$	-2.35	0.34	0.00	-2.43	-0.21	0.00	20.90	-0.51	0.00	-0.30
$3.0\le\alpha<4.0$	-1.72	-0.01	0.00	-2.93	-0.01	0.00	11.80	0.07	0.00	-0.10
$4.0\le\alpha<6.0$	6.31	0.05	0.00	-6.18	-0.04	0.00	-2.75	-0.02	0.00	-0.40
$6.0\le\alpha<8.0$	5.22	0.01	0.00	-5.46	-0.01	0.00	-2.19	0.00	0.00	-0.40
$8.0\le\alpha<10$	1.48	0.02	0.00	-3.03	-0.02	0.00	-0.72	0.00	0.00	-0.20
$10\le\alpha<15$	-5.30	-1.38	0.01	2.60	1.31	-0.01	0.33	0.07	0.00	-0.18
$15\le\alpha<40$	19.70	-0.02	0.00	-24.60	0.02	0.00	-0.35	0.00	0.00	-0.40
$40\le\alpha<85$	8.97	1.24	-0.02	-14.10	-1.96	0.02	-0.05	-0.01	0.00	-0.40

Regression Coefficients for Spectral Class 112 - σ=150										
	X_1	X_2	X_3	X_4	X_5	X6	X_7	X_8	X_9	Y
$\alpha<0.4$	13.50	-0.03	0.00	-14.84	-0.03	0.00	1682.66	-7.12	0.02	-0.20
$0.4\le\alpha<0.7$	63.36	-0.79	0.00	-38.83	0.35	0.00	-850.06	21.62	-0.09	-0.20
$0.7\le\alpha<1.0$	80.66	3.43	-0.02	-67.26	-2.60	0.02	56.75	-25.46	0.15	-0.10
$1.0\le\alpha<3.0$	37.43	-0.09	0.00	-25.64	-0.01	0.00	-38.57	0.48	0.00	-0.20
$3.0\le\alpha<4.0$	-0.65	-0.08	0.00	1.42	0.00	0.00	1.59	0.27	0.00	-0.20
$4.0\le\alpha<6.0$	1.54	0.15	0.00	0.20	-0.13	0.00	-3.23	-0.02	0.00	-0.40
$6.0\le\alpha<8.0$	-8.90	0.17	0.00	8.34	-0.16	0.00	0.77	-0.01	0.00	-0.20
$8.0\le\alpha<10$	-30.84	0.64	0.00	26.40	-0.55	0.00	4.61	-0.09	0.00	-0.30
$10\le\alpha<15$	-8.34	0.47	0.00	8.00	-0.45	0.00	0.51	-0.02	0.00	-0.20
$15\le\alpha<40$	1.40	0.06	0.00	-1.37	-0.06	0.00	-0.02	0.00	0.00	-0.20
$40\le\alpha<85$	-18.59	0.06	0.00	23.65	-0.05	0.00	0.05	0.00	0.00	-0.20

Regression Coefficients for Spectral Class 113 - σ=150										
	X_1	X_2	X_3	X_4	X_5	X6	X_7	X_8	X_9	Y
α<0.4	-8.41	-0.22	0.00	-2.21	0.02	0.00	2425.96	11.58	-0.07	-0.40
0.4≤α<0.7	-30.59	0.82	0.00	5.71	-0.34	0.00	1892.12	-36.40	0.14	-0.30
0.7≤α<1.0	67.21	0.66	0.00	-57.62	-0.58	0.00	-89.90	-1.98	0.02	-0.10
1.0≤α<3.0	8.31	-0.05	0.00	-4.57	-0.02	0.00	-18.24	0.33	0.00	-0.50
3.0≤α<4.0	-0.81	-0.04	0.00	-1.03	-0.03	0.00	3.20	0.22	0.00	-0.10
4.0≤α<6.0	-0.33	0.22	0.00	-0.73	-0.19	0.00	-0.94	-0.05	0.00	-0.30
6.0≤α<8.0	0.67	0.09	0.00	-1.69	-0.09	0.00	-0.57	-0.01	0.00	-0.30
8.0≤α<10	-3.18	0.01	0.00	1.53	-0.02	0.00	0.07	0.00	0.00	-0.25
10≤α<15	-2.86	0.00	0.00	1.15	-0.01	0.00	0.14	0.00	0.00	-0.10
15≤α<40	-1.32	-0.03	0.00	-0.37	0.02	0.00	0.02	0.00	0.00	-1.30
40≤α<85	4.84	1.09	-0.01	-9.93	-1.74	0.01	-0.01	0.00	0.00	-0.40

Regression Coefficients for Spectral Class 114 - σ=150										
	X_1	X_2	X_3	X_4	X_5	X6	X_7	X_8	X_9	Y
α<0.4	18.90	-0.48	0.00	-16.03	0.16	0.00	519.80	38.03	-0.16	-0.20
0.4≤α<0.7	41.52	-0.37	0.00	-27.17	0.13	0.00	-323.25	10.58	-0.05	-0.20
0.7≤α<1.0	78.41	2.64	-0.02	-64.92	-2.03	0.01	20.91	-19.18	0.11	-0.10
1.0≤α<3.0	37.32	-0.10	0.00	-25.31	-0.01	0.00	-43.61	0.53	0.00	-0.20
3.0≤α<4.0	4.52	-0.05	0.00	-1.86	-0.02	0.00	-7.71	0.29	0.00	-0.30
4.0≤α<6.0	-3.69	0.22	0.00	3.21	-0.17	0.00	-0.71	-0.07	0.00	-0.40
6.0≤α<8.0	-3.87	0.10	0.00	3.00	-0.08	0.00	0.52	-0.02	0.00	-0.40
8.0≤α<10	-26.85	-0.21	0.00	25.35	0.18	0.00	1.04	0.02	0.00	-0.10
10≤α<15	-2.08	-0.27	0.00	1.65	0.24	0.00	-0.04	0.02	0.00	-0.20
15≤α<40	-0.26	0.05	0.00	-0.53	-0.07	0.00	0.03	0.00	0.00	-0.30
40≤α<85	-17.37	0.03	0.00	24.56	0.01	0.00	0.06	0.00	0.00	-0.30

Regression Coefficients for Spectral Class 115 - σ=150										
	X_1	X_2	X_3	X_4	X_5	X6	X_7	X_8	X_9	Y
α<0.4	10.19	-0.23	0.00	-14.34	0.07	0.00	1476.87	11.95	-0.05	-0.20
0.4≤α<0.7	25.46	-0.05	0.00	-21.21	-0.01	0.00	136.90	0.68	-0.01	-0.20
0.7≤α<1.0	16.59	-0.02	0.00	-12.12	-0.02	0.00	70.17	-1.32	0.01	-0.30
1.0≤α<3.0	10.75	-0.08	0.00	-5.54	0.00	0.00	-15.03	0.32	0.00	-0.50
3.0≤α<4.0	-0.99	-0.22	0.00	-0.32	0.12	0.00	7.43	0.30	0.00	-0.20
4.0≤α<6.0	6.54	0.15	0.00	-4.77	-0.13	0.00	-2.75	-0.03	0.00	-0.30
6.0≤α<8.0	1.87	0.03	0.00	-1.29	-0.04	0.00	-0.83	0.00	0.00	-0.40
8.0≤α<10	-9.12	-0.10	0.00	8.56	0.07	0.00	0.44	0.02	0.00	-0.10
10≤α<15	-1.71	0.33	0.00	1.55	-0.33	0.00	0.07	-0.01	0.00	-0.20
15≤α<40	-5.72	0.03	0.00	5.86	-0.03	0.00	0.09	0.00	0.00	-0.20
40≤α<85	-25.98	0.64	-0.01	33.46	-0.78	0.01	0.06	0.00	0.00	-0.20

Regression Coefficients for Spectral Class 116 - σ=150										
	X_1	X_2	X_3	X_4	X_5	X6	X_7	X_8	X_9	Y
α<0.4	38.73	-0.23	0.00	-24.46	0.07	0.00	185.81	2.77	0.05	-0.20
0.4≤α<0.7	40.12	-0.69	0.00	-12.61	0.15	0.00	-1252.81	33.21	-0.14	-0.40
0.7≤α<1.0	198.48	2.37	-0.02	-166.21	-2.00	0.02	-295.95	-13.66	0.10	-0.07
1.0≤α<3.0	24.06	-0.02	0.00	-11.41	-0.05	0.00	-55.67	0.70	0.00	-0.30
3.0≤α<4.0	-3.12	0.05	0.00	4.72	-0.07	0.00	-2.56	0.17	0.00	-0.20
4.0≤α<6.0	18.28	-0.08	0.00	-9.44	0.05	0.00	-15.66	0.03	0.00	-0.40
6.0≤α<8.0	-39.13	-0.13	0.00	35.57	0.11	0.00	2.18	0.01	0.00	-0.20
8.0≤α<10	-86.49	-0.02	0.00	73.48	0.01	0.00	12.84	0.00	0.00	-0.25
10≤α<15	16.94	0.72	0.00	-16.34	-0.71	0.00	-0.72	-0.02	0.00	-0.17
15≤α<40	-0.73	0.02	0.00	5.07	-0.06	0.00	0.02	0.00	0.00	-4.80
40≤α<85	-4.23	0.86	-0.01	6.76	-1.56	0.02	0.03	-0.01	0.00	-0.50

Regression Coefficients for Spectral Class 117 - σ=150

	X_1	X_2	X_3	X_4	X_5	X6	X_7	X_8	X_9	Y
$\alpha<0.4$	19.07	-0.01	0.00	-18.86	-0.04	0.00	1514.45	-4.63	0.02	-0.17
$0.4\le\alpha<0.7$	31.97	-0.59	0.00	-11.44	0.13	0.00	-1012.30	28.27	-0.12	-0.40
$0.7\le\alpha<1.0$	128.85	0.00	0.00	-113.25	-0.06	0.00	62.31	-2.97	0.02	-0.07
$1.0\le\alpha<3.0$	25.92	-0.11	0.00	-14.11	0.00	0.00	-42.09	0.60	0.00	-0.30
$3.0\le\alpha<4.0$	-2.13	-0.12	0.00	3.14	0.03	0.00	-0.08	0.34	0.00	-0.20
$4.0\le\alpha<6.0$	0.72	0.19	0.00	0.93	-0.14	0.00	-2.64	-0.06	0.00	-0.40
$6.0\le\alpha<8.0$	-1.51	0.00	0.00	2.39	-0.02	0.00	-1.45	0.02	0.00	-0.40
$8.0\le\alpha<10$	-24.69	-0.16	0.00	21.94	0.13	0.00	2.68	0.03	0.00	-0.24
$10\le\alpha<15$	-8.63	0.46	0.00	8.08	-0.44	0.00	0.53	-0.02	0.00	-0.20
$15\le\alpha<40$	1.93	0.13	0.00	-2.18	-0.13	0.00	-0.04	0.00	0.00	-0.20
$40\le\alpha<85$	-2.33	0.38	-0.01	3.18	-0.59	0.01	0.01	0.00	0.00	-0.40

Regression Coefficients for Spectral Class 118 - σ=150

	X_1	X_2	X_3	X_4	X_5	X6	X_7	X_8	X_9	Y
$\alpha<0.4$	15.25	-0.27	0.00	-14.30	0.08	0.00	1135.51	17.22	-0.05	-0.20
$0.4\le\alpha<0.7$	26.00	-0.46	0.00	-9.67	0.09	0.00	-678.45	21.03	-0.09	-0.40
$0.7\le\alpha<1.0$	93.91	0.22	0.00	-83.54	-0.25	0.00	172.19	-3.13	0.01	-0.07
$1.0\le\alpha<3.0$	14.09	-0.08	0.00	-5.03	-0.01	0.00	-31.37	0.51	0.00	-0.50
$3.0\le\alpha<4.0$	-1.04	-0.04	0.00	2.59	-0.03	0.00	-1.98	0.28	0.00	-0.20
$4.0\le\alpha<6.0$	1.57	0.16	0.00	0.61	-0.13	0.00	-4.31	-0.04	0.00	-0.40
$6.0\le\alpha<8.0$	-9.10	0.10	0.00	8.39	-0.10	0.00	0.23	-0.01	0.00	-0.30
$8.0\le\alpha<10$	-25.94	-0.16	0.00	22.83	0.14	0.00	2.93	0.03	0.00	-0.24
$10\le\alpha<15$	-4.67	0.03	0.00	4.08	-0.03	0.00	0.42	0.00	0.00	-0.40
$15\le\alpha<40$	3.51	0.05	0.00	-4.00	-0.05	0.00	-0.07	0.00	0.00	-0.20
$40\le\alpha<85$	-4.86	0.15	0.00	6.91	-0.23	0.01	0.03	0.00	0.00	-0.40

Regression Coefficients for Spectral Class 119 - σ=150

	X_1	X_2	X_3	X_4	X_5	X6	X_7	X_8	X_9	Y
$\alpha<0.4$	-9.18	-0.13	0.00	-1.96	0.00	0.00	2170.47	9.74	-0.06	-0.40
$0.4\le\alpha<0.7$	-5.41	0.16	0.00	-2.38	-0.07	0.00	770.92	-11.54	0.04	-0.40
$0.7\le\alpha<1.0$	27.08	0.16	0.00	-21.03	-0.15	0.00	57.71	-2.65	0.01	-0.20
$1.0\le\alpha<3.0$	31.40	0.00	0.00	-23.21	-0.06	0.00	-28.44	0.31	0.00	-0.20
$3.0\le\alpha<4.0$	-0.87	-0.04	0.00	-0.13	-0.02	0.00	3.91	0.18	0.00	-0.40
$4.0\le\alpha<6.0$	5.98	0.29	0.00	-4.95	-0.26	0.00	-2.86	-0.03	0.00	-0.20
$6.0\le\alpha<8.0$	-0.16	0.05	0.00	-0.15	-0.05	0.00	-0.54	0.00	0.00	-0.40
$8.0\le\alpha<10$	-18.11	-0.14	0.00	16.46	0.11	0.00	0.94	0.02	0.00	-0.10
$10\le\alpha<15$	-2.96	0.03	0.00	2.00	-0.05	0.00	0.25	0.00	0.00	-0.20
$15\le\alpha<40$	0.11	0.02	0.00	-1.19	-0.04	0.00	-0.02	0.00	0.00	-1.50
$40\le\alpha<85$	-9.76	0.33	0.00	15.15	-0.52	0.01	0.05	0.00	0.00	-0.40

Regression Coefficients for Spectral Class 120 - σ=150

	X_1	X_2	X_3	X_4	X_5	X6	X_7	X_8	X_9	Y
$\alpha<0.4$	22.09	-0.10	0.00	-18.40	0.01	0.00	1691.50	-15.37	0.06	-0.20
$0.4\le\alpha<0.7$	48.64	-0.45	0.00	-30.66	0.17	0.00	-275.02	8.17	-0.03	-0.20
$0.7\le\alpha<1.0$	16.85	-0.28	0.00	-5.63	0.04	0.00	-105.21	3.91	-0.02	-0.50
$1.0\le\alpha<3.0$	19.69	0.00	0.00	-10.71	-0.06	0.00	-33.66	0.45	0.00	-0.30
$3.0\le\alpha<4.0$	-2.47	-0.20	0.00	2.88	0.09	0.00	0.82	0.39	0.00	-0.20
$4.0\le\alpha<6.0$	1.11	0.16	0.00	0.32	-0.13	0.00	-2.76	-0.03	0.00	-0.40
$6.0\le\alpha<8.0$	-1.30	0.06	0.00	1.69	-0.06	0.00	-0.46	0.00	0.00	-0.30
$8.0\le\alpha<10$	-41.32	0.90	0.00	35.18	-0.77	0.00	6.17	-0.13	0.00	-0.30
$10\le\alpha<15$	-8.28	0.44	0.00	7.96	-0.42	0.00	0.35	-0.02	0.00	-0.20
$15\le\alpha<40$	1.02	0.03	0.00	-1.35	-0.03	0.00	-0.01	0.00	0.00	-0.20
$40\le\alpha<85$	-12.35	0.22	0.00	15.32	-0.25	0.01	0.03	0.00	0.00	-0.20

Regression Coefficients for Spectral Class 121 - σ=150										
	X_1	X_2	X_3	X_4	X_5	X6	X_7	X_8	X_9	Y
α<0.4	23.42	0.03	0.00	-18.57	-0.04	0.00	1667.12	-25.65	0.11	-0.20
0.4≤α<0.7	67.26	-0.82	0.00	-39.44	0.36	0.00	-824.17	20.74	-0.09	-0.20
0.7≤α<1.0	78.60	3.97	-0.02	-63.32	-3.02	0.02	40.23	-28.39	0.17	-0.10
1.0≤α<3.0	22.42	-0.02	0.00	-11.48	-0.05	0.00	-41.39	0.53	0.00	-0.30
3.0≤α<4.0	-4.56	0.01	0.00	5.40	-0.06	0.00	-1.30	0.28	0.00	-0.20
4.0≤α<6.0	-2.20	0.22	0.00	2.90	-0.16	0.00	-1.60	-0.07	0.00	-0.40
6.0≤α<8.0	-5.07	0.06	0.00	5.31	-0.05	0.00	-0.12	0.00	0.00	-0.20
8.0≤α<10	-16.72	-0.07	0.00	15.35	0.06	0.00	1.46	0.02	0.00	-0.24
10≤α<15	7.72	-0.41	0.00	-7.10	0.40	0.00	-0.57	0.02	0.00	-0.17
15≤α<40	0.48	-0.02	0.00	-0.80	0.03	0.00	-0.01	0.00	0.00	-0.30
40≤α<85	-0.53	0.00	0.00	149.16	13.58	-0.05	0.01	0.00	0.00	-4.80

Regression Coefficients for Spectral Class 122 - σ=150										
	X_1	X_2	X_3	X_4	X_5	X6	X_7	X_8	X_9	Y
α<0.4	25.79	-0.02	0.00	-18.59	-0.04	0.00	1406.30	-19.81	0.08	-0.20
0.4≤α<0.7	76.05	-1.02	0.00	-42.83	0.45	0.00	-1094.75	26.85	-0.11	-0.20
0.7≤α<1.0	112.40	0.22	0.00	-96.56	-0.28	0.00	74.26	-2.66	0.01	-0.07
1.0≤α<3.0	13.80	-0.06	0.00	-4.00	-0.03	0.00	-45.69	0.70	0.00	-0.50
3.0≤α<4.0	-2.55	0.04	0.00	4.15	-0.08	0.00	-4.19	0.23	0.00	-0.20
4.0≤α<6.0	-9.89	0.33	0.00	-7.83	-0.22	0.00	2.26	-0.14	0.00	-0.40
6.0≤α<8.0	4.49	-0.16	0.00	-2.54	0.12	0.00	-2.35	0.06	0.00	-0.40
8.0≤α<10	-38.16	0.64	0.00	32.58	-0.53	0.00	5.57	-0.10	0.00	-0.30
10≤α<15	-3.56	-0.02	0.00	3.57	0.02	0.00	-0.05	0.00	0.00	-0.10
15≤α<40	-0.23	0.01	0.00	-0.36	0.00	0.00	-0.01	0.00	0.00	-4.70
40≤α<85	-0.66	0.01	0.00	108.63	8.65	0.04	0.01	0.00	0.00	-4.80

Regression Coefficients for Spectral Class 123 - σ=150										
	X_1	X_2	X_3	X_4	X_5	X6	X_7	X_8	X_9	Y
α<0.4	-15.95	-0.13	0.00	-0.30	0.00	0.00	3892.18	-9.42	0.00	-0.60
0.4≤α<0.7	-43.13	1.11	0.00	10.39	-0.45	0.00	2493.51	-50.46	0.20	-0.30
0.7≤α<1.0	70.37	0.35	0.00	-59.13	-0.38	0.00	-157.20	1.01	0.00	-0.10
1.0≤α<3.0	5.35	0.01	0.00	-3.47	-0.04	0.00	-12.63	0.20	0.00	-0.50
3.0≤α<4.0	0.40	-0.03	0.00	-2.42	-0.03	0.00	2.25	0.22	0.00	-0.10
4.0≤α<6.0	0.69	0.35	0.00	-1.92	-0.31	0.00	-1.78	-0.05	0.00	-0.20
6.0≤α<8.0	1.64	0.07	0.00	-2.77	-0.07	0.00	-1.32	-0.01	0.00	-0.30
8.0≤α<10	-1.54	-0.06	0.00	-0.41	0.05	0.00	-0.34	0.00	0.00	-0.20
10≤α<15	-4.06	-0.10	0.00	1.79	0.10	0.00	-0.02	0.00	0.00	-0.17
15≤α<40	-2.92	-0.03	0.00	1.37	0.05	0.00	0.12	0.00	0.00	-4.80
40≤α<85	1.01	0.22	0.00	-18.16	-1.55	0.01	0.00	0.00	0.00	-1.60

Regression Coefficients for Spectral Class 201 - σ=150										
	X_1	X_2	X_3	X_4	X_5	X6	X_7	X_8	X_9	Y
α<0.4	-1.42	-0.20	0.00	-3.56	0.02	0.00	2626.13	-6.80	0.03	-0.40
0.4≤α<0.7	0.74	0.24	0.00	-4.76	-0.13	0.00	1067.66	-20.43	0.08	-0.30
0.7≤α<1.0	39.72	-0.11	0.00	-25.51	-0.03	0.00	-155.01	2.11	-0.01	-0.20
1.0≤α<3.0	29.47	0.05	0.00	-19.76	-0.12	0.00	-43.85	0.57	0.00	-0.20
3.0≤α<4.0	-2.38	-0.18	0.00	2.08	0.07	0.00	0.91	0.38	0.00	-0.20
4.0≤α<6.0	25.43	-0.07	0.00	-19.43	0.02	0.00	-11.14	0.11	0.00	-0.20
6.0≤α<8.0	-13.71	0.27	0.00	9.75	-0.21	0.00	4.46	-0.08	0.00	-0.40
8.0≤α<10	-40.40	0.91	0.00	33.97	-0.78	0.00	6.12	-0.13	0.00	-0.30
10≤α<15	3.03	0.16	0.00	-3.04	-0.17	0.00	-0.30	0.00	0.00	-0.20
15≤α<40	3.77	0.12	0.00	-4.56	-0.13	0.00	-0.05	0.00	0.00	-0.20
40≤α<85	-1.14	0.90	-0.01	0.87	-1.43	0.01	0.01	0.00	0.00	-0.40

Regression Coefficients for Spectral Class 202 - σ=150										
	X_1	X_2	X_3	X_4	X_5	X6	X_7	X_8	X_9	Y
α<0.4	18.93	-0.25	0.00	-17.67	0.09	0.00	2476.04	-18.41	0.11	-0.20
0.4≤α<0.7	4.81	-0.01	0.00	-4.59	-0.02	0.00	666.79	-9.49	0.04	-0.40
0.7≤α<1.0	46.98	-0.22	0.00	-30.06	0.05	0.00	-179.74	2.26	0.00	-0.20
1.0≤α<3.0	13.93	0.13	0.00	-8.19	-0.12	0.00	-13.22	0.09	0.00	-0.30
3.0≤α<4.0	-2.21	-0.07	0.00	2.10	0.00	0.00	5.54	0.25	0.00	-0.20
4.0≤α<6.0	4.85	0.22	0.00	-2.46	-0.17	0.00	-2.52	-0.05	0.00	-0.30
6.0≤α<8.0	8.23	0.04	0.00	-5.35	-0.04	0.00	-2.55	-0.01	0.00	-0.30
8.0≤α<10	1.02	-0.05	0.00	0.80	0.03	0.00	-1.53	0.01	0.00	-0.20
10≤α<15	-13.65	-0.67	0.00	13.76	0.64	0.00	0.11	0.04	0.00	-0.18
15≤α<40	0.29	0.00	0.00	-5.48	0.03	0.00	-0.02	0.00	0.00	-4.80
40≤α<85	-0.51	-0.01	0.00	372.29	21.34	-0.29	0.00	0.00	0.00	-4.80

Regression Coefficients for Spectral Class 203 - σ=150										
	X_1	X_2	X_3	X_4	X_5	X6	X_7	X_8	X_9	Y
α<0.4	6.18	-0.38	0.00	-2.85	0.03	0.00	1509.59	13.82	-0.03	-0.50
0.4≤α<0.7	61.49	-0.79	0.00	-34.60	0.29	0.00	-712.25	18.13	-0.07	-0.20
0.7≤α<1.0	24.13	-0.42	0.00	-6.34	0.05	0.00	-235.02	5.96	-0.02	-0.50
1.0≤α<3.0	1.07	0.33	0.00	0.32	-0.26	0.00	-2.57	-0.15	0.00	-0.30
3.0≤α<4.0	-3.83	-0.17	0.00	4.19	0.05	0.00	-2.29	0.46	0.00	-0.20
4.0≤α<6.0	55.50	-0.54	0.00	-42.27	0.38	0.00	-23.82	0.30	0.00	-0.20
6.0≤α<8.0	-7.84	0.07	0.00	6.70	-0.07	0.00	1.32	-0.01	0.00	-0.20
8.0≤α<10	-69.64	1.59	-0.01	58.54	-1.34	0.01	11.09	-0.25	0.00	-0.30
10≤α<15	-3.88	0.21	0.00	3.86	-0.21	0.00	-0.02	0.00	0.00	-0.20
15≤α<40	-0.46	-0.05	0.00	0.08	0.06	0.00	0.01	0.00	0.00	-0.20
40≤α<85	-12.15	-0.47	0.01	16.74	0.75	-0.01	0.05	0.00	0.00	-0.30

Regression Coefficients for Spectral Class 204 - σ=150										
	X_1	X_2	X_3	X_4	X_5	X6	X_7	X_8	X_9	Y
α<0.4	8.16	0.13	0.00	-15.32	-0.10	0.00	2161.92	-15.01	0.04	-0.17
0.4≤α<0.7	5.13	0.11	0.00	-7.98	-0.06	0.00	607.50	-9.11	0.03	-0.30
0.7≤α<1.0	5.53	-0.07	0.00	-4.06	0.00	0.00	44.40	1.03	0.00	-0.50
1.0≤α<3.0	21.20	-0.05	0.00	-13.97	-0.01	0.00	-16.10	0.18	0.00	-0.30
3.0≤α<4.0	-0.37	-0.32	0.00	-0.59	0.19	0.00	8.73	0.33	0.00	-0.20
4.0≤α<6.0	11.06	0.07	0.00	-7.42	-0.09	0.00	-6.00	0.01	0.00	-0.30
6.0≤α<8.0	0.51	0.05	0.00	0.26	-0.08	0.00	-1.51	0.03	0.00	-0.10
8.0≤α<10	-35.40	-0.21	0.00	33.50	0.17	0.00	1.50	0.03	0.00	-0.10
10≤α<15	11.63	-0.67	0.00	-11.90	0.62	0.00	-0.22	0.04	0.00	-0.17
15≤α<40	0.19	0.01	0.00	-0.64	-0.02	0.00	-0.02	0.00	0.00	-4.80
40≤α<85	-23.50	0.41	-0.01	29.70	-0.50	0.01	0.06	0.00	0.00	-0.20

Regression Coefficients for Spectral Class 205 - σ=150										
	X_1	X_2	X_3	X_4	X_5	X6	X_7	X_8	X_9	Y
α<0.4	12.84	-0.40	0.00	-9.23	0.09	0.00	1395.04	13.01	-0.02	-0.30
0.4≤α<0.7	-6.55	-0.13	0.00	-0.01	0.00	0.00	775.59	-2.20	0.01	-1.80
0.7≤α<1.0	47.54	-0.23	0.00	-29.81	0.04	0.00	-166.07	1.66	0.00	-0.20
1.0≤α<3.0	14.05	0.10	0.00	-7.66	-0.12	0.00	-22.14	0.22	0.00	-0.30
3.0≤α<4.0	-2.50	-0.20	0.00	2.64	0.09	0.00	2.03	0.37	0.00	-0.20
4.0≤α<6.0	0.14	0.23	0.00	1.00	-0.20	0.00	-2.89	-0.04	0.00	-0.30
6.0≤α<8.0	-1.90	0.03	0.00	2.26	-0.05	0.00	-0.93	0.02	0.00	-0.20
8.0≤α<10	-39.13	-0.25	0.00	36.89	0.23	0.00	1.98	0.02	0.00	-0.10
10≤α<15	-5.76	0.22	0.00	5.30	-0.22	0.00	0.21	-0.01	0.00	-0.20
15≤α<40	-2.58	-0.03	0.00	2.26	0.03	0.00	0.03	0.00	0.00	-0.20
40≤α<85	-20.95	-0.17	0.00	26.04	0.25	0.00	0.06	0.00	0.00	-0.20

Regression Coefficients for Spectral Class 206 - σ=150										
	X_1	X_2	X_3	X_4	X_5	X6	X_7	X_8	X_9	Y
α<0.4	22.84	-0.24	0.00	-19.17	0.09	0.00	2098.23	-15.02	0.09	-0.20
0.4≤α<0.7	8.27	-0.06	0.00	-5.35	-0.01	0.00	521.92	-6.68	0.03	-0.40
0.7≤α<1.0	76.80	3.26	-0.02	-62.06	-2.51	0.02	-55.81	-21.33	0.13	-0.10
1.0≤α<3.0	24.18	0.22	0.00	-16.44	-0.21	0.00	-16.54	0.00	0.00	-0.20
3.0≤α<4.0	0.59	-0.10	0.00	0.69	0.02	0.00	3.02	0.22	0.00	-0.20
4.0≤α<6.0	0.74	0.56	0.00	1.82	-0.54	0.00	-5.25	0.01	0.00	-0.10
6.0≤α<8.0	-11.82	0.17	0.00	11.15	-0.16	0.00	0.66	-0.02	0.00	-0.20
8.0≤α<10	-25.23	-0.16	0.00	24.36	0.14	0.00	0.91	0.01	0.00	-0.10
10≤α<15	-7.49	0.00	0.00	7.13	-0.01	0.00	0.40	0.00	0.00	-0.30
15≤α<40	10.50	0.23	0.00	-11.48	-0.24	0.00	-0.13	0.00	0.00	-0.20
40≤α<85	-0.09	0.24	0.00	-0.54	-0.37	0.01	0.00	0.00	0.00	-0.40

Regression Coefficients for Spectral Class 207 - σ=150										
	X_1	X_2	X_3	X_4	X_5	X6	X_7	X_8	X_9	Y
α<0.4	3.63	-0.35	0.00	-1.10	0.01	0.00	1259.02	16.85	-0.04	-0.70
0.4≤α<0.7	61.24	-0.76	0.00	-34.03	0.27	0.00	-708.24	17.35	-0.07	-0.20
0.7≤α<1.0	57.94	-0.45	0.00	-33.33	0.12	0.00	-274.43	3.26	-0.01	-0.20
1.0≤α<3.0	-6.50	0.71	0.00	5.45	-0.58	0.00	7.26	-0.41	0.00	-0.20
3.0≤α<4.0	3.15	-0.04	0.00	-1.02	-0.04	0.00	-6.63	0.30	0.00	-0.30
4.0≤α<6.0	28.42	-0.11	0.00	-21.08	0.04	0.00	-14.45	0.16	0.00	-0.20
6.0≤α<8.0	25.16	-0.50	0.00	-21.11	0.40	0.00	-5.29	0.10	0.00	-0.20
8.0≤α<10	-49.12	-0.27	0.00	45.94	0.24	0.00	2.84	0.03	0.00	-0.10
10≤α<15	-9.64	0.54	0.00	8.75	-0.53	0.00	0.56	-0.02	0.00	-0.20
15≤α<40	5.44	0.20	0.00	-6.09	-0.20	0.00	-0.10	0.00	0.00	-0.20
40≤α<85	-1.13	1.22	-0.01	0.54	-1.94	0.02	0.01	-0.01	0.00	-0.40

Regression Coefficients for Spectral Class 208 - σ=150										
	X_1	X_2	X_3	X_4	X_5	X6	X_7	X_8	X_9	Y
α<0.4	24.16	-0.52	0.00	-10.03	0.09	0.00	-1326.93	64.92	-0.24	-0.30
0.4≤α<0.7	65.36	-1.28	0.01	-18.02	0.28	0.00	-2700.30	65.27	-0.27	-0.40
0.7≤α<1.0	86.94	4.59	-0.03	-66.93	-3.50	0.02	84.31	-35.33	0.21	-0.10
1.0≤α<3.0	66.38	-0.69	0.00	-38.50	0.30	0.00	-198.05	3.11	-0.01	-0.20
3.0≤α<4.0	-0.06	-0.08	0.00	-0.74	0.03	0.00	5.92	0.19	0.00	-0.20
4.0≤α<6.0	191.87	-3.29	0.01	-118.44	2.02	-0.01	-130.64	2.23	-0.01	-0.40
6.0≤α<8.0	-186.17	2.91	-0.01	131.47	-2.07	0.01	67.51	-1.05	0.00	-0.40
8.0≤α<10	-139.58	-1.05	0.02	135.09	0.91	-0.01	3.56	0.15	0.00	-0.10
10≤α<15	86.51	-2.30	0.01	-82.37	2.18	-0.01	-5.10	0.14	0.00	-0.20
15≤α<40	0.02	-0.01	0.00	-4.75	0.10	0.00	-0.05	0.00	0.00	-4.80
40≤α<85	-16.04	1.27	-0.01	21.66	-1.79	0.01	0.06	0.00	0.00	-0.30

Regression Coefficients for Spectral Class 209 - σ=150

	X_1	X_2	X_3	X_4	X_5	X6	X_7	X_8	X_9	Y
α<0.4	19.70	-0.09	0.00	-14.83	-0.01	0.00	1087.64	5.11	-0.01	-0.20
0.4≤α<0.7	59.54	-0.93	0.00	-24.29	0.29	0.00	-1533.58	36.63	-0.15	-0.30
0.7≤α<1.0	80.73	4.55	-0.03	-63.52	-3.44	0.02	70.72	-33.23	0.20	-0.10
1.0≤α<3.0	39.12	-0.04	0.00	-23.46	-0.05	0.00	-63.79	0.60	0.00	-0.20
3.0≤α<4.0	-2.63	0.04	0.00	6.03	-0.10	0.00	-17.18	0.28	0.00	-0.20
4.0≤α<6.0	-71.10	0.49	0.00	58.63	-0.43	0.00	15.17	-0.03	0.00	-0.20
6.0≤α<8.0	36.18	-0.27	0.00	-32.81	0.25	0.00	-1.24	-0.02	0.00	-0.20
8.0≤α<10	39.90	0.28	0.00	-32.87	-0.30	0.00	-7.40	0.02	0.00	-0.16
10≤α<15	2.36	0.67	0.00	-2.93	-0.63	0.00	0.11	-0.04	0.00	-0.20
15≤α<40	-4.04	0.14	0.00	3.93	-0.14	0.00	0.04	0.00	0.00	-0.20
40≤α<85	-0.75	0.01	0.00	226.40	-1.68	0.08	0.01	0.00	0.00	-4.80

Regression Coefficients for Spectral Class 210 - σ=150

	X_1	X_2	X_3	X_4	X_5	X6	X_7	X_8	X_9	Y
α<0.4	-5.73	-0.10	0.00	-5.55	0.01	0.00	2284.93	-0.84	-0.02	-0.30
0.4≤α<0.7	-11.00	0.09	0.00	-1.04	-0.02	0.00	963.56	-14.49	0.06	-0.60
0.7≤α<1.0	30.01	0.06	0.00	-24.27	-0.09	0.00	2.59	-1.51	0.01	-0.20
1.0≤α<3.0	7.56	-0.06	0.00	-5.03	-0.01	0.00	-15.97	0.32	0.00	-0.50
3.0≤α<4.0	-6.15	-0.06	0.00	2.15	-0.01	0.00	7.24	0.20	0.00	-0.10
4.0≤α<6.0	2.16	0.18	0.00	-3.45	-0.16	0.00	-1.51	-0.06	0.00	-0.30
6.0≤α<8.0	1.59	0.01	0.00	-2.93	-0.03	0.00	-1.15	-0.01	0.00	-0.40
8.0≤α<10	-3.63	-0.15	0.00	1.17	0.10	0.00	0.00	0.03	0.00	-0.40
10≤α<15	5.44	-2.06	0.01	-8.34	1.93	-0.01	0.32	0.12	0.00	-0.18
15≤α<40	6.18	0.05	0.00	-13.26	-0.10	0.00	-0.34	0.00	0.00	-1.60
40≤α<85	8.77	0.86	-0.02	-13.92	-1.23	0.03	-0.02	0.00	0.00	-0.30

Regression Coefficients for Spectral Class 211 - σ=150

	X_1	X_2	X_3	X_4	X_5	X6	X_7	X_8	X_9	Y
α<0.4	-17.37	-0.19	0.00	2.25	-0.01	0.00	1653.77	28.24	-0.14	-0.20
0.4≤α<0.7	-27.08	0.61	0.00	5.39	-0.28	0.00	1574.63	-27.27	0.10	-0.30
0.7≤α<1.0	59.76	1.36	-0.01	-51.08	-1.13	0.01	-56.00	-7.26	0.05	-0.10
1.0≤α<3.0	18.84	0.20	0.00	-15.02	-0.21	0.00	-23.46	0.21	0.00	-0.20
3.0≤α<4.0	-4.54	-0.07	0.00	1.60	0.00	0.00	3.70	0.25	0.00	-0.10
4.0≤α<6.0	-0.34	0.36	0.00	-1.43	-0.32	0.00	-0.88	-0.06	0.00	-0.20
6.0≤α<8.0	23.80	0.08	0.00	-23.93	-0.09	0.00	-2.32	0.00	0.00	-0.10
8.0≤α<10	-3.72	-0.02	0.00	1.10	0.00	0.00	0.47	0.00	0.00	-0.60
10≤α<15	7.93	-1.98	0.01	-10.15	1.87	-0.01	-0.05	0.11	0.00	-0.18
15≤α<40	2.62	0.01	0.00	-9.93	-0.06	0.00	-0.19	0.00	0.00	-2.40
40≤α<85	17.84	1.64	-0.02	-29.75	-2.59	0.03	-0.09	-0.01	0.00	-0.40

Regression Coefficients for Spectral Class 212 - σ=150

	X_1	X_2	X_3	X_4	X_5	X6	X_7	X_8	X_9	Y
α<0.4	18.80	-0.60	0.00	-5.92	0.08	0.00	43.01	44.46	-0.15	-0.40
0.4≤α<0.7	88.87	-1.38	0.01	-46.57	0.57	0.00	-1647.06	38.45	-0.16	-0.20
0.7≤α<1.0	85.02	4.56	-0.03	-63.60	-3.54	0.02	-88.69	-31.91	0.20	-0.10
1.0≤α<3.0	-57.67	1.73	-0.01	37.85	-1.21	0.00	136.50	-3.00	0.01	-0.20
3.0≤α<4.0	-9.04	0.07	0.00	11.39	-0.17	0.00	-29.51	0.79	0.00	-0.20
4.0≤α<6.0	57.86	-1.13	0.00	-31.43	0.61	0.00	-51.30	0.99	0.00	-0.50
6.0≤α<8.0	30.73	-0.50	0.00	-23.39	0.37	0.00	-8.89	0.16	0.00	-0.40
8.0≤α<10	-101.66	-0.35	0.01	94.42	0.35	-0.01	7.03	0.00	0.00	-0.10
10≤α<15	-12.81	0.04	0.00	12.60	-0.03	0.00	-0.04	-0.01	0.00	-0.17
15≤α<40	1.80	-0.21	0.00	-3.05	0.20	0.00	-0.03	0.01	0.00	-0.20
40≤α<85	-12.28	0.15	0.00	15.60	-0.17	0.00	0.06	0.00	0.00	-0.30

Regression Coefficients for Spectral Class 213 - σ=150										
	X_1	X_2	X_3	X_4	X_5	X6	X_7	X_8	X_9	Y
α<0.4	0.82	-0.48	0.00	-6.09	0.14	0.00	825.71	44.27	-0.18	-0.20
0.4≤α<0.7	-18.30	0.48	0.00	2.64	-0.23	0.00	1184.12	-18.18	0.07	-0.30
0.7≤α<1.0	63.70	0.40	0.00	-53.56	-0.39	0.00	-56.26	-0.59	0.01	-0.10
1.0≤α<3.0	32.93	-0.01	0.00	-23.32	-0.06	0.00	-30.01	0.25	0.00	-0.20
3.0≤α<4.0	-3.18	-0.14	0.00	2.92	0.04	0.00	-0.11	0.34	0.00	-0.20
4.0≤α<6.0	-3.59	0.17	0.00	2.67	-0.13	0.00	-2.00	-0.03	0.00	-0.50
6.0≤α<8.0	-9.83	0.18	0.00	6.83	-0.14	0.00	1.61	-0.03	0.00	-0.40
8.0≤α<10	-1.62	-0.27	0.00	0.21	0.24	0.00	0.08	0.04	0.00	-0.26
10≤α<15	2.06	0.45	0.00	-3.18	-0.42	0.00	-0.16	-0.03	0.00	-0.18
15≤α<40	-3.59	-0.10	0.00	3.47	0.14	0.00	0.11	0.01	0.00	-1.40
40≤α<85	-6.18	2.10	-0.01	5.68	-2.67	0.01	0.05	0.00	0.00	-0.20

Regression Coefficients for Spectral Class 214 - σ=150										
	X_1	X_2	X_3	X_4	X_5	X6	X_7	X_8	X_9	Y
α<0.4	8.13	-0.31	0.00	-8.13	0.09	0.00	1017.93	20.28	-0.03	-0.30
0.4≤α<0.7	26.58	-0.49	0.00	-10.22	0.11	0.00	-718.60	23.21	-0.10	-0.40
0.7≤α<1.0	28.26	-0.19	0.00	-15.59	0.07	0.00	-34.07	0.98	0.00	-0.30
1.0≤α<3.0	41.27	-0.09	0.00	-27.84	0.02	0.00	-31.96	0.24	0.00	-0.20
3.0≤α<4.0	-0.06	0.00	0.00	2.18	-0.04	0.00	2.41	0.10	0.00	-0.20
4.0≤α<6.0	19.10	-0.03	0.00	-10.01	-0.01	0.00	-18.50	0.09	0.00	-0.30
6.0≤α<8.0	-34.27	0.23	0.00	27.02	-0.18	0.00	5.19	-0.03	0.00	-0.40
8.0≤α<10	-85.21	0.69	0.00	71.61	-0.58	0.00	12.91	-0.11	0.00	-0.24
10≤α<15	1.21	2.05	-0.01	-2.24	-1.95	0.01	0.49	-0.11	0.00	-0.18
15≤α<40	-1.29	-0.01	0.00	8.68	0.03	0.00	0.02	0.00	0.00	-4.80
40≤α<85	-1.30	0.10	0.00	162.98	-57.46	0.78	0.02	0.00	0.00	-4.80

Regression Coefficients for Spectral Class 215 - σ=150										
	X_1	X_2	X_3	X_4	X_5	X6	X_7	X_8	X_9	Y
α<0.4	-3.83	-0.07	0.00	0.00	0.00	0.00	558.17	-30.48	0.22	-1.80
0.4≤α<0.7	-17.83	0.03	0.00	5.20	-0.05	0.00	716.17	-6.24	0.02	-0.30
0.7≤α<1.0	-13.94	-0.20	0.00	8.20	0.05	0.00	102.34	4.80	-0.03	-0.10
1.0≤α<3.0	6.61	0.26	0.00	-5.78	-0.22	0.00	0.33	-0.02	0.00	-0.20
3.0≤α<4.0	-1.11	-0.03	0.00	-0.03	-0.01	0.00	4.67	0.18	0.00	-0.10
4.0≤α<6.0	5.88	0.05	0.00	-3.98	-0.05	0.00	-3.33	0.01	0.00	-0.40
6.0≤α<8.0	1.51	0.08	0.00	-1.17	-0.06	0.00	-0.76	-0.01	0.00	-0.40
8.0≤α<10	-0.40	-0.01	0.00	0.33	0.01	0.00	-0.31	0.01	0.00	-0.17
10≤α<15	6.43	-0.18	0.00	-6.11	0.18	0.00	-0.72	0.01	0.00	-0.17
15≤α<40	-2.12	-0.01	0.00	3.25	0.05	0.00	0.13	0.00	0.00	-3.10
40≤α<85	-10.21	0.56	0.00	14.54	-0.78	0.00	0.04	0.00	0.00	-0.30

Regression Coefficients for Spectral Class 216 - σ=150										
	X_1	X_2	X_3	X_4	X_5	X6	X_7	X_8	X_9	Y
α<0.4	24.21	-0.48	0.00	-18.20	0.16	0.00	751.13	26.18	-0.09	-0.20
0.4≤α<0.7	57.82	-0.70	0.00	-34.60	0.28	0.00	-681.93	17.90	-0.07	-0.20
0.7≤α<1.0	33.19	-0.35	0.00	-16.68	0.09	0.00	-124.89	2.75	-0.01	-0.30
1.0≤α<3.0	32.01	0.01	0.00	-20.76	-0.10	0.00	-46.16	0.56	0.00	-0.20
3.0≤α<4.0	-3.96	-0.12	0.00	4.35	0.02	0.00	-1.87	0.37	0.00	-0.20
4.0≤α<6.0	-0.75	0.16	0.00	1.45	-0.14	0.00	-2.34	-0.04	0.00	-0.40
6.0≤α<8.0	-3.34	0.02	0.00	3.43	-0.04	0.00	-0.77	0.02	0.00	-0.20
8.0≤α<10	-19.41	-0.13	0.00	16.82	0.10	0.00	2.23	0.03	0.00	-0.24
10≤α<15	-5.26	0.17	0.00	4.67	-0.17	0.00	0.25	0.00	0.00	-0.20
15≤α<40	-0.83	0.06	0.00	0.43	-0.06	0.00	0.00	0.00	0.00	-0.20
40≤α<85	-19.35	0.07	0.00	23.78	-0.06	0.00	0.06	0.00	0.00	-0.20

Regression Coefficients for Spectral Class 217 - σ=150										
	X_1	X_2	X_3	X_4	X_5	X6	X_7	X_8	X_9	Y
α<0.4	9.12	0.07	0.00	-15.37	-0.05	0.00	1799.18	-13.57	0.04	-0.20
0.4≤α<0.7	28.92	-0.10	0.00	-24.23	0.02	0.00	-6.19	3.19	-0.02	-0.20
0.7≤α<1.0	7.60	-0.04	0.00	-7.08	0.00	0.00	99.75	-0.83	0.00	-0.40
1.0≤α<3.0	36.89	-0.12	0.00	-28.88	0.04	0.00	-24.67	0.30	0.00	-0.20
3.0≤α<4.0	-0.82	0.00	0.00	-1.47	-0.03	0.00	9.18	0.07	0.00	-0.30
4.0≤α<6.0	12.81	0.23	0.00	-11.37	-0.21	0.00	-2.78	-0.04	0.00	-0.20
6.0≤α<8.0	2.80	0.05	0.00	-2.88	-0.06	0.00	-0.63	0.00	0.00	-0.30
8.0≤α<10	-2.86	-0.07	0.00	1.73	0.05	0.00	0.57	0.02	0.00	-0.20
10≤α<15	4.58	0.16	0.00	-5.29	-0.17	0.00	0.15	0.00	0.00	-0.17
15≤α<40	12.67	0.11	0.00	-13.37	-0.11	0.00	-0.20	0.00	0.00	-0.20
40≤α<85	2.60	1.06	-0.01	-5.38	-1.71	0.02	-0.01	-0.01	0.00	-0.40

Regression Coefficients for Spectral Class 218 - σ=150										
	X_1	X_2	X_3	X_4	X_5	X6	X_7	X_8	X_9	Y
α<0.4	-7.57	-0.33	0.00	-1.64	0.03	0.00	1182.89	35.68	-0.17	-0.30
0.4≤α<0.7	-88.23	1.90	-0.01	27.43	-0.75	0.00	3812.74	-76.11	0.30	-0.30
0.7≤α<1.0	48.64	-2.66	0.02	-42.51	1.83	-0.01	-310.04	27.05	-0.15	-0.10
1.0≤α<3.0	4.29	0.25	0.00	-6.18	-0.17	0.00	6.97	-0.32	0.00	-0.30
3.0≤α<4.0	-2.52	-0.01	0.00	-2.09	-0.02	0.00	10.24	0.11	0.00	-0.10
4.0≤α<6.0	3.06	0.05	0.00	-3.70	-0.04	0.00	-2.42	-0.01	0.00	-0.50
6.0≤α<8.0	4.07	0.08	0.00	-5.28	-0.07	0.00	-1.39	-0.02	0.00	-0.30
8.0≤α<10	-1.37	0.04	0.00	-0.71	-0.03	0.00	-0.44	-0.02	0.00	-0.60
10≤α<15	-5.55	-0.08	0.00	3.03	0.08	0.00	0.00	0.00	0.00	-0.17
15≤α<40	-3.77	-0.03	0.00	1.69	0.05	0.00	0.19	0.00	0.00	-2.50
40≤α<85	0.79	0.07	0.00	-593.12	-21.44	0.21	-0.01	0.00	0.00	-4.40

Regression Coefficients for Spectral Class 219 - σ=150										
	X_1	X_2	X_3	X_4	X_5	X6	X_7	X_8	X_9	Y
α<0.4	-9.76	-0.05	0.00	-3.84	-0.05	0.00	2301.70	7.92	-0.09	-0.20
0.4≤α<0.7	-144.79	4.42	-0.02	91.52	-3.22	0.01	3020.36	-63.63	0.25	-0.10
0.7≤α<1.0	60.00	-0.89	0.01	-53.18	0.57	0.00	-153.38	10.82	-0.06	-0.10
1.0≤α<3.0	9.20	0.01	0.00	-7.03	-0.03	0.00	-6.72	0.05	0.00	-0.40
3.0≤α<4.0	-1.27	-0.01	0.00	-2.01	-0.04	0.00	8.32	0.13	0.00	-0.10
4.0≤α<6.0	4.32	0.07	0.00	-4.11	-0.07	0.00	-3.35	-0.01	0.00	-0.40
6.0≤α<8.0	-1.71	0.09	0.00	-0.18	-0.08	0.00	0.00	-0.02	0.00	-0.40
8.0≤α<10	-3.93	0.02	0.00	1.59	-0.02	0.00	0.54	-0.01	0.00	-0.25
10≤α<15	-16.77	0.45	0.00	14.00	-0.44	0.00	1.02	-0.02	0.00	-0.17
15≤α<40	-0.54	0.00	0.00	-2.80	-0.02	0.00	0.00	0.00	0.00	-2.80
40≤α<85	-0.27	0.82	-0.01	-0.73	-1.31	0.01	0.01	0.00	0.00	-0.40

Regression Coefficients for Spectral Class 220 - σ=150										
	X_1	X_2	X_3	X_4	X_5	X6	X_7	X_8	X_9	Y
α<0.4	-3.96	-0.30	0.00	-4.45	0.03	0.00	1076.67	36.59	-0.20	-0.20
0.4≤α<0.7	-75.51	1.67	-0.01	22.63	-0.66	0.00	3290.45	-65.09	0.26	-0.30
0.7≤α<1.0	51.48	-2.08	0.01	-45.29	1.42	-0.01	-258.45	21.86	-0.12	-0.10
1.0≤α<3.0	6.71	0.21	0.00	-7.45	-0.14	0.00	4.41	-0.25	0.00	-0.30
3.0≤α<4.0	0.64	0.01	0.00	-4.57	-0.04	0.00	10.19	0.09	0.00	-0.10
4.0≤α<6.0	8.20	0.09	0.00	-8.02	-0.07	0.00	-2.35	-0.02	0.00	-0.30
6.0≤α<8.0	5.81	0.04	0.00	-6.27	-0.04	0.00	-1.37	-0.01	0.00	-0.30
8.0≤α<10	-1.02	0.06	0.00	-0.83	-0.05	0.00	0.18	-0.01	0.00	-0.26
10≤α<15	-5.21	0.31	0.00	3.12	-0.29	0.00	0.46	-0.02	0.00	-0.17
15≤α<40	-1.88	-0.12	0.00	0.57	0.11	0.00	0.03	0.00	0.00	-0.20
40≤α<85	3.41	0.85	-0.01	-7.35	-1.37	0.01	0.00	0.00	0.00	-0.40

Regression Coefficients for Spectral Class 221 - σ=150										
	X_1	X_2	X_3	X_4	X_5	X6	X_7	X_8	X_9	Y
α<0.4	-12.35	-0.22	0.00	-0.83	0.01	0.00	1861.23	6.98	0.01	-0.50
0.4≤α<0.7	-275.86	6.83	-0.03	183.96	-4.92	0.02	4955.80	-103.98	0.41	-0.10
0.7≤α<1.0	46.13	-2.21	0.01	-42.73	1.53	-0.01	-250.19	23.13	-0.13	-0.10
1.0≤α<3.0	-1.89	0.08	0.00	-2.12	-0.03	0.00	15.14	-0.24	0.00	-0.60
3.0≤α<4.0	-1.62	0.04	0.00	-3.91	-0.05	0.00	12.60	0.04	0.00	-0.10
4.0≤α<6.0	9.69	0.06	0.00	-9.88	-0.05	0.00	-3.53	-0.01	0.00	-0.30
6.0≤α<8.0	3.96	0.02	0.00	-5.17	-0.02	0.00	-1.97	-0.01	0.00	-0.40
8.0≤α<10	-0.20	-0.01	0.00	-2.29	0.00	0.00	-0.56	0.00	0.00	-0.20
10≤α<15	4.04	-1.39	0.01	-7.12	1.33	-0.01	-0.07	0.07	0.00	-0.18
15≤α<40	4.92	0.11	0.00	-8.82	-0.14	0.00	0.11	0.00	0.00	-0.30
40≤α<85	-27.79	2.22	-0.02	36.90	-2.80	0.02	0.05	-0.01	0.00	-0.20

Regression Coefficients for Spectral Class 222 - σ=150										
	X_1	X_2	X_3	X_4	X_5	X6	X_7	X_8	X_9	Y
α<0.4	21.66	-0.01	0.00	-17.98	-0.03	0.00	1667.24	-20.39	0.08	-0.20
0.4≤α<0.7	65.48	-0.81	0.00	-38.86	0.35	0.00	-804.61	20.27	-0.08	-0.20
0.7≤α<1.0	34.91	-0.37	0.00	-17.50	0.11	0.00	-149.15	3.46	-0.01	-0.30
1.0≤α<3.0	32.56	0.03	0.00	-21.24	-0.10	0.00	-39.98	0.44	0.00	-0.20
3.0≤α<4.0	5.82	-0.04	0.00	-2.20	-0.03	0.00	-8.45	0.27	0.00	-0.30
4.0≤α<6.0	-1.35	0.20	0.00	2.27	-0.15	0.00	-2.16	-0.05	0.00	-0.40
6.0≤α<8.0	-6.73	0.08	0.00	6.64	-0.08	0.00	0.06	0.00	0.00	-0.20
8.0≤α<10	-15.83	-0.08	0.00	14.34	0.06	0.00	1.51	0.02	0.00	-0.24
10≤α<15	-7.85	0.38	0.00	7.55	-0.37	0.00	0.34	-0.02	0.00	-0.20
15≤α<40	-0.21	0.01	0.00	0.07	-0.01	0.00	0.00	0.00	0.00	-4.80
40≤α<85	-1.00	0.02	0.00	404.95	5.39	0.05	0.01	0.00	0.00	-4.80

Regression Coefficients for Spectral Class 223 - σ=150										
	X_1	X_2	X_3	X_4	X_5	X6	X_7	X_8	X_9	Y
α<0.4	12.86	-0.13	0.00	-14.53	0.02	0.00	1691.62	-0.24	-0.01	-0.20
0.4≤α<0.7	47.44	-0.46	0.00	-30.91	0.18	0.00	-378.93	11.01	-0.05	-0.20
0.7≤α<1.0	27.46	-0.24	0.00	-15.42	0.06	0.00	-60.36	1.49	0.00	-0.30
1.0≤α<3.0	34.05	-0.03	0.00	-23.72	-0.05	0.00	-35.50	0.42	0.00	-0.20
3.0≤α<4.0	-0.49	-0.19	0.00	0.80	0.08	0.00	1.28	0.35	0.00	-0.20
4.0≤α<6.0	1.36	0.10	0.00	-0.16	-0.09	0.00	-2.75	-0.02	0.00	-0.50
6.0≤α<8.0	-4.57	0.05	0.00	4.64	-0.07	0.00	-0.43	0.02	0.00	-0.10
8.0≤α<10	-25.98	-0.18	0.00	24.59	0.15	0.00	1.15	0.02	0.00	-0.10
10≤α<15	-6.23	0.29	0.00	5.69	-0.29	0.00	0.32	-0.01	0.00	-0.20
15≤α<40	0.97	0.05	0.00	-1.50	-0.05	0.00	-0.03	0.00	0.00	-0.50
40≤α<85	-6.69	0.34	-0.01	10.21	-0.53	0.01	0.03	0.00	0.00	-0.40

Regression Coefficients for Spectral Class 224 - σ=150										
	X_1	X_2	X_3	X_4	X_5	X6	X_7	X_8	X_9	Y
α<0.4	-4.36	-0.30	0.00	-2.23	0.03	0.00	1025.70	37.55	-0.15	-0.40
0.4≤α<0.7	-7.92	0.31	0.00	-1.62	-0.16	0.00	874.88	-13.21	0.05	-0.30
0.7≤α<1.0	23.50	0.22	0.00	-18.22	-0.19	0.00	79.87	-2.99	0.01	-0.20
1.0≤α<3.0	31.34	-0.01	0.00	-22.43	-0.07	0.00	-35.50	0.42	0.00	-0.20
3.0≤α<4.0	3.58	-0.04	0.00	-1.62	-0.02	0.00	-7.47	0.20	0.00	-0.60
4.0≤α<6.0	0.54	0.10	0.00	-0.40	-0.08	0.00	-2.07	-0.02	0.00	-0.50
6.0≤α<8.0	-1.51	0.08	0.00	0.59	-0.07	0.00	0.17	-0.02	0.00	-0.40
8.0≤α<10	-16.19	-0.16	0.00	14.81	0.14	0.00	0.46	0.02	0.00	-0.10
10≤α<15	4.69	-0.28	0.00	-5.45	0.25	0.00	-0.19	0.02	0.00	-0.20
15≤α<40	0.51	0.07	0.00	-1.53	-0.09	0.00	0.00	0.00	0.00	-0.40
40≤α<85	-22.62	0.32	0.00	27.93	-0.40	0.01	0.07	0.00	0.00	-0.20

Regression Coefficients for Spectral Class 225 - σ=150

	X_1	X_2	X_3	X_4	X_5	X6	X_7	X_8	X_9	Y
α<0.4	24.49	-0.47	0.00	-10.74	0.09	0.00	-299.45	36.68	-0.12	-0.30
0.4≤α<0.7	93.78	-1.41	0.01	-49.93	0.61	0.00	-1713.18	39.90	-0.16	-0.20
0.7≤α<1.0	90.71	3.73	-0.02	-68.98	-2.89	0.02	-54.55	-27.13	0.17	-0.10
1.0≤α<3.0	26.94	0.10	0.00	-14.55	-0.19	0.00	-75.39	0.97	0.00	-0.20
3.0≤α<4.0	-1.94	-0.08	0.00	2.85	0.01	0.00	-0.90	0.23	0.00	-0.20
4.0≤α<6.0	39.14	-0.36	0.00	-28.75	0.24	0.00	-20.02	0.24	0.00	-0.20
6.0≤α<8.0	-34.98	0.29	0.00	29.35	-0.25	0.00	6.96	-0.06	0.00	-0.20
8.0≤α<10	-7.97	-0.19	0.00	7.06	0.13	0.00	0.66	0.06	0.00	-0.40
10≤α<15	4.36	-0.08	0.00	-4.01	0.07	0.00	-0.57	0.01	0.00	-0.30
15≤α<40	-0.23	0.01	0.00	-1.52	-0.02	0.00	-0.02	0.00	0.00	-4.80
40≤α<85	-14.10	0.44	-0.01	16.92	-0.54	0.01	0.05	0.00	0.00	-0.20

Regression Coefficients for Spectral Class 226 - σ=150

	X_1	X_2	X_3	X_4	X_5	X6	X_7	X_8	X_9	Y
α<0.4	-5.47	-0.33	0.00	-2.22	0.09	0.00	168.75	16.54	0.01	-0.20
0.4≤α<0.7	-31.61	0.43	0.00	5.40	-0.14	0.00	1621.20	-24.17	0.09	-0.40
0.7≤α<1.0	-9.74	0.53	0.00	0.36	-0.37	0.00	242.45	-3.34	0.01	-0.20
1.0≤α<3.0	21.73	0.12	0.00	-17.85	-0.13	0.00	-12.39	0.05	0.00	-0.20
3.0≤α<4.0	1.48	0.00	0.00	-3.54	-0.05	0.00	4.46	0.17	0.00	-0.10
4.0≤α<6.0	4.45	0.30	0.00	-4.89	-0.27	0.00	-1.63	-0.05	0.00	-0.20
6.0≤α<8.0	0.37	0.05	0.00	-1.33	-0.04	0.00	-0.57	-0.02	0.00	-0.50
8.0≤α<10	-8.02	0.24	0.00	5.54	-0.21	0.00	0.96	-0.04	0.00	-0.30
10≤α<15	-21.43	0.66	0.00	19.05	-0.64	0.00	0.92	-0.03	0.00	-0.17
15≤α<40	6.60	0.18	0.00	-9.15	-0.21	0.00	0.07	0.00	0.00	-0.20
40≤α<85	-22.72	0.98	0.00	34.04	-1.34	0.00	0.06	0.00	0.00	-0.30

Regression Coefficients for Spectral Class 227 - σ=150

	X_1	X_2	X_3	X_4	X_5	X6	X_7	X_8	X_9	Y
α<0.4	-3.82	-0.04	0.00	-9.65	-0.01	0.00	2322.14	-3.21	-0.01	-0.20
0.4≤α<0.7	-56.17	1.31	-0.01	12.61	-0.49	0.00	2801.58	-55.86	0.22	-0.30
0.7≤α<1.0	-10.64	0.20	0.00	-1.25	-0.06	0.00	217.43	-2.50	0.01	-0.50
1.0≤α<3.0	12.05	0.07	0.00	-12.25	-0.05	0.00	1.71	-0.14	0.00	-0.30
3.0≤α<4.0	2.50	-0.24	0.00	-7.04	0.17	0.00	11.93	0.18	0.00	-0.20
4.0≤α<6.0	19.05	0.13	0.00	-18.88	-0.11	0.00	-2.44	-0.05	0.00	-0.20
6.0≤α<8.0	4.54	-0.02	0.00	-5.68	0.01	0.00	-0.91	0.00	0.00	-0.40
8.0≤α<10	-5.06	-0.03	0.00	1.98	0.02	0.00	1.21	0.00	0.00	-0.10
10≤α<15	5.66	-0.27	0.00	-8.03	0.24	0.00	0.49	0.02	0.00	-0.20
15≤α<40	15.07	0.06	0.00	-17.56	-0.07	0.00	-0.36	0.00	0.00	-0.40
40≤α<85	12.79	1.38	-0.02	-22.05	-2.20	0.03	-0.05	-0.01	0.00	-0.40

Regression Coefficients for Spectral Class 301 - σ=150										
	X_1	X_2	X_3	X_4	X_5	X6	X_7	X_8	X_9	Y
$\alpha<0.4$	0.62	-0.18	0.00	-10.13	0.05	0.00	2390.16	3.18	-0.03	-0.20
$0.4\le\alpha<0.7$	-10.97	0.09	0.00	-0.78	-0.02	0.00	917.73	-12.31	0.05	-0.60
$0.7\le\alpha<1.0$	20.68	0.30	0.00	-18.52	-0.21	0.00	125.37	-4.22	0.02	-0.20
$1.0\le\alpha<3.0$	33.93	-0.07	0.00	-25.89	-0.01	0.00	-29.29	0.34	0.00	-0.20
$3.0\le\alpha<4.0$	1.53	-0.03	0.00	-3.22	-0.03	0.00	4.71	0.19	0.00	-0.10
$4.0\le\alpha<6.0$	4.59	0.15	0.00	-4.11	-0.14	0.00	-2.71	-0.02	0.00	-0.30
$6.0\le\alpha<8.0$	-0.95	0.03	0.00	-0.12	-0.04	0.00	-0.15	-0.01	0.00	-0.60
$8.0\le\alpha<10$	-21.24	-0.15	0.00	18.87	0.12	0.00	1.18	0.02	0.00	-0.10
$10\le\alpha<15$	-2.02	-0.02	0.00	0.24	0.00	0.00	0.57	0.01	0.00	-0.30
$15\le\alpha<40$	0.11	0.01	0.00	-2.78	-0.06	0.00	-0.02	0.00	0.00	-3.70
$40\le\alpha<85$	-1.66	0.05	0.00	801.79	-20.38	0.31	0.03	0.00	0.00	-4.80

Regression Coefficients for Spectral Class 302 - σ=150										
	X_1	X_2	X_3	X_4	X_5	X6	X_7	X_8	X_9	Y
$\alpha<0.4$	36.69	-0.55	0.00	-24.25	0.22	0.00	-231.11	33.84	-0.09	-0.20
$0.4\le\alpha<0.7$	36.50	-0.68	0.00	-12.27	0.15	0.00	-1197.04	32.54	-0.13	-0.40
$0.7\le\alpha<1.0$	133.34	-0.07	0.00	-115.93	0.00	0.00	46.25	-2.81	0.02	-0.07
$1.0\le\alpha<3.0$	26.56	-0.11	0.00	-13.82	0.00	0.00	-44.88	0.58	0.00	-0.30
$3.0\le\alpha<4.0$	-1.82	-0.02	0.00	3.65	-0.04	0.00	-1.76	0.22	0.00	-0.20
$4.0\le\alpha<6.0$	10.29	-0.01	0.00	-4.54	-0.04	0.00	-12.67	0.10	0.00	-0.30
$6.0\le\alpha<8.0$	-29.28	0.30	0.00	21.88	-0.23	0.00	7.93	-0.09	0.00	-0.40
$8.0\le\alpha<10$	-21.41	-0.09	0.00	17.91	0.08	0.00	3.51	0.01	0.00	-0.24
$10\le\alpha<15$	2.24	0.09	0.00	-1.79	-0.10	0.00	-0.37	0.00	0.00	-0.20
$15\le\alpha<40$	-0.93	0.05	0.00	0.77	-0.05	0.00	0.01	0.00	0.00	-0.60
$40\le\alpha<85$	-6.11	0.12	0.00	10.13	-0.19	0.01	0.04	0.00	0.00	-0.50

Regression Coefficients for Spectral Class 303 - σ=150										
	X_1	X_2	X_3	X_4	X_5	X6	X_7	X_8	X_9	Y
$\alpha<0.4$	22.42	-0.24	0.00	-19.10	0.08	0.00	694.88	13.76	-0.03	-0.20
$0.4\le\alpha<0.7$	33.06	-0.63	0.00	-12.15	0.14	0.00	-1170.26	32.41	-0.14	-0.40
$0.7\le\alpha<1.0$	58.03	1.96	-0.01	-56.13	-1.62	0.01	390.77	-12.81	0.05	-0.07
$1.0\le\alpha<3.0$	26.97	-0.14	0.00	-15.44	0.03	0.00	-37.13	0.55	0.00	-0.30
$3.0\le\alpha<4.0$	-1.87	-0.05	0.00	2.40	-0.02	0.00	2.88	0.25	0.00	-0.20
$4.0\le\alpha<6.0$	1.86	0.17	0.00	0.05	-0.13	0.00	-2.79	-0.04	0.00	-0.40
$6.0\le\alpha<8.0$	-9.03	0.05	0.00	9.56	-0.06	0.00	-0.38	0.02	0.00	-0.10
$8.0\le\alpha<10$	-23.31	-0.16	0.00	22.74	0.15	0.00	0.88	0.02	0.00	-0.10
$10\le\alpha<15$	14.89	-0.57	0.00	-13.55	0.55	0.00	-1.08	0.03	0.00	-0.17
$15\le\alpha<40$	-2.28	-0.01	0.00	2.19	0.02	0.00	0.06	0.00	0.00	-0.30
$40\le\alpha<85$	-1.36	-0.02	0.00	848.57	25.33	-0.15	0.02	0.00	0.00	-4.80

Regression Coefficients for Spectral Class 304 - σ=150										
	X_1	X_2	X_3	X_4	X_5	X6	X_7	X_8	X_9	Y
$\alpha<0.4$	7.37	-0.52	0.00	-10.56	0.19	0.00	794.98	20.07	-0.03	-0.20
$0.4\le\alpha<0.7$	-38.51	0.79	0.00	9.05	-0.33	0.00	1993.66	-34.45	0.13	-0.30
$0.7\le\alpha<1.0$	55.91	-0.20	0.00	-49.01	0.05	0.00	-83.56	4.49	-0.02	-0.10
$1.0\le\alpha<3.0$	25.67	0.08	0.00	-20.25	-0.11	0.00	-20.72	0.17	0.00	-0.20
$3.0\le\alpha<4.0$	-1.04	-0.03	0.00	-1.27	-0.02	0.00	5.29	0.19	0.00	-0.10
$4.0\le\alpha<6.0$	5.12	0.14	0.00	-4.78	-0.12	0.00	-2.58	-0.02	0.00	-0.30
$6.0\le\alpha<8.0$	1.19	0.05	0.00	-1.81	-0.05	0.00	-0.97	-0.01	0.00	-0.40
$8.0\le\alpha<10$	-3.87	-0.07	0.00	2.22	0.05	0.00	0.18	0.01	0.00	-0.24
$10\le\alpha<15$	-14.97	0.39	0.00	12.75	-0.38	0.00	0.79	-0.02	0.00	-0.17
$15\le\alpha<40$	-1.25	-0.01	0.00	-1.68	-0.03	0.00	0.08	0.00	0.00	-4.80
$40\le\alpha<85$	-25.04	0.88	-0.01	31.67	-1.10	0.01	0.06	0.00	0.00	-0.20

Regression Coefficients for Spectral Class 305 - σ=150										
	X_1	X_2	X_3	X_4	X_5	X6	X_7	X_8	X_9	Y
α<0.4	-15.86	-0.02	0.00	0.00	0.00	0.00	1724.03	-19.68	0.12	-2.40
0.4≤α<0.7	4.87	-0.33	0.00	-6.90	0.10	0.00	82.12	10.88	-0.05	-0.30
0.7≤α<1.0	-11.24	-0.05	0.00	0.00	0.00	0.00	402.10	-0.89	0.00	-4.80
1.0≤α<3.0	22.13	-0.13	0.00	-14.64	0.03	0.00	-23.49	0.40	0.00	-0.30
3.0≤α<4.0	-5.13	-0.11	0.00	2.54	0.04	0.00	9.72	0.23	0.00	-0.20
4.0≤α<6.0	7.38	0.29	0.00	-6.31	-0.26	0.00	-1.94	-0.05	0.00	-0.20
6.0≤α<8.0	1.34	0.08	0.00	-1.32	-0.08	0.00	-0.31	-0.01	0.00	-0.30
8.0≤α<10	-5.91	-0.06	0.00	5.15	0.04	0.00	0.57	0.01	0.00	-0.10
10≤α<15	-0.43	0.19	0.00	0.19	-0.20	0.00	0.08	0.00	0.00	-0.20
15≤α<40	1.22	0.08	0.00	-1.56	-0.09	0.00	-0.01	0.00	0.00	-0.40
40≤α<85	-14.65	0.58	-0.01	21.46	-0.79	0.01	0.05	0.00	0.00	-0.30

Regression Coefficients for Spectral Class 306 - σ=150										
	X_1	X_2	X_3	X_4	X_5	X6	X_7	X_8	X_9	Y
α<0.4	-12.61	-0.07	0.00	0.00	0.00	0.00	2633.69	-29.18	0.16	-4.80
0.4≤α<0.7	10.85	-0.19	0.00	-10.42	0.04	0.00	366.50	2.58	-0.02	-0.20
0.7≤α<1.0	17.65	-0.13	0.00	-10.30	0.01	0.00	32.94	0.58	0.00	-0.30
1.0≤α<3.0	15.63	-0.08	0.00	-7.12	-0.02	0.00	-34.14	0.52	0.00	-0.40
3.0≤α<4.0	-3.52	-0.06	0.00	3.76	-0.02	0.00	-2.72	0.34	0.00	-0.20
4.0≤α<6.0	-6.41	0.40	0.00	5.85	-0.35	0.00	-0.43	-0.05	0.00	-0.20
6.0≤α<8.0	0.02	0.04	0.00	0.24	-0.04	0.00	-1.07	0.01	0.00	-0.40
8.0≤α<10	-29.44	0.07	0.00	28.08	-0.07	0.00	0.78	0.00	0.00	-0.07
10≤α<15	-6.21	0.04	0.00	5.37	-0.04	0.00	0.27	0.00	0.00	-0.30
15≤α<40	0.99	-0.22	0.00	-1.92	0.23	0.00	-0.02	0.00	0.00	-0.20
40≤α<85	-15.74	0.76	0.00	18.60	-0.97	0.00	0.06	0.00	0.00	-0.20

Regression Coefficients for Spectral Class 307 - σ=150										
	X_1	X_2	X_3	X_4	X_5	X6	X_7	X_8	X_9	Y
α<0.4	-11.82	-0.09	0.00	-2.49	-0.01	0.00	3409.14	-9.70	-0.01	-0.30
0.4≤α<0.7	-34.41	0.91	0.00	6.88	-0.37	0.00	2123.15	-42.02	0.17	-0.30
0.7≤α<1.0	74.84	0.34	0.00	-63.28	-0.35	0.00	-152.18	0.38	0.00	-0.10
1.0≤α<3.0	9.37	0.01	0.00	-6.24	-0.05	0.00	-15.05	0.21	0.00	-0.40
3.0≤α<4.0	-4.04	-0.06	0.00	1.25	-0.01	0.00	5.92	0.21	0.00	-0.10
4.0≤α<6.0	-0.69	0.12	0.00	-0.58	-0.09	0.00	-0.68	-0.05	0.00	-0.50
6.0≤α<8.0	2.16	0.06	0.00	-3.03	-0.06	0.00	-0.88	-0.01	0.00	-0.30
8.0≤α<10	-6.06	-0.09	0.00	4.10	0.08	0.00	0.35	0.01	0.00	-0.10
10≤α<15	-16.69	0.55	0.00	14.33	-0.54	0.00	0.81	-0.03	0.00	-0.17
15≤α<40	-6.49	0.04	0.00	5.25	-0.05	0.00	0.13	0.00	0.00	-0.20
40≤α<85	-2.61	0.75	-0.01	3.39	-1.19	0.01	0.02	0.00	0.00	-0.40

Regression Coefficients for Spectral Class 101 - σ=20000										
	X_1	X_2	X_3	X_4	X_5	X6	X_7	X_8	X_9	Y
α<0.4	3.14	-0.02	0.00	0.06	0.01	0.00	-43.55	0.79	0.00	-0.20
0.4≤α<0.7	-2.14	0.10	0.00	1.90	-0.04	0.00	200.21	-3.64	0.02	-0.30
0.7≤α<1.0	2.78	-0.03	0.00	0.37	0.02	0.00	-37.93	1.36	-0.01	-0.10
1.0≤α<3.0	0.00	0.12	0.00	1.89	-0.07	0.00	-12.88	0.00	0.00	-0.20
3.0≤α<4.0	2.94	0.09	0.00	-0.71	-0.05	0.00	-8.84	-0.06	0.00	-0.20
4.0≤α<6.0	-11.82	-0.03	0.00	9.87	0.06	0.00	3.91	-0.05	0.00	-0.20
6.0≤α<8.0	-14.43	0.07	0.00	11.17	-0.03	0.00	5.36	-0.07	0.00	-0.30
8.0≤α<10	-7.43	-0.38	0.00	7.08	0.35	0.00	1.49	0.02	0.00	-0.20
10≤α<15	-22.44	-0.50	0.00	22.99	0.47	0.00	0.60	0.03	0.00	-0.17
15≤α<40	1.38	0.00	0.00	-4.04	-0.08	0.00	-0.11	0.00	0.00	-4.80
40≤α<85	-12.28	0.14	-0.01	14.94	-0.17	0.01	0.04	0.00	0.00	-0.20

Regression Coefficients for Spectral Class 102 - σ=20000										
	X_1	X_2	X_3	X_4	X_5	X6	X_7	X_8	X_9	Y
α<0.4	3.12	-0.05	0.00	0.33	0.02	0.00	-119.58	4.79	-0.01	-0.20
0.4≤α<0.7	-2.71	0.12	0.00	2.26	-0.05	0.00	205.87	-3.34	0.01	-0.30
0.7≤α<1.0	6.19	-0.15	0.00	-1.95	0.11	0.00	-63.21	2.51	-0.01	-0.10
1.0≤α<3.0	1.12	0.13	0.00	1.39	-0.07	0.00	-21.87	-0.03	0.00	-0.20
3.0≤α<4.0	0.31	0.00	0.00	0.93	0.02	0.00	-9.94	-0.03	0.00	-0.40
4.0≤α<6.0	-17.65	-0.10	0.00	12.24	0.10	0.00	9.94	-0.08	0.00	-0.30
6.0≤α<8.0	-26.85	-0.22	0.00	19.94	0.17	0.00	10.52	0.03	0.00	-0.30
8.0≤α<10	29.40	-0.43	0.00	-25.16	0.34	0.00	-2.04	0.07	0.00	-0.30
10≤α<15	3.91	-0.04	0.00	-1.24	0.01	0.00	-0.46	0.02	0.00	-0.10
15≤α<40	1.74	0.00	0.00	0.59	0.01	0.00	-0.09	0.00	0.00	-2.90
40≤α<85	-1.48	-0.03	0.00	1,099.85	36.35	-0.25	0.03	0.00	0.00	-4.80

Regression Coefficients for Spectral Class 103 - σ=20000										
	X_1	X_2	X_3	X_4	X_5	X6	X_7	X_8	X_9	Y
α<0.4	1.30	0.03	0.00	0.14	0.00	0.00	-20.31	1.23	0.00	-0.50
0.4≤α<0.7	1.32	0.02	0.00	0.48	0.00	0.00	-3.58	0.92	0.00	-0.10
0.7≤α<1.0	1.33	0.08	0.00	0.41	-0.03	0.00	-21.60	0.28	0.00	-0.20
1.0≤α<3.0	-5.75	0.22	0.00	4.69	-0.11	0.00	7.44	-0.36	0.00	-0.20
3.0≤α<4.0	4.63	0.09	0.00	-3.73	-0.02	0.00	5.35	-0.29	0.00	-0.10
4.0≤α<6.0	4.17	-0.06	0.00	-1.19	0.05	0.00	-4.42	0.03	0.00	-0.60
6.0≤α<8.0	-39.95	0.55	0.00	26.99	-0.35	0.00	16.77	-0.27	0.00	-0.50
8.0≤α<10	-50.99	-1.43	0.01	45.91	1.28	-0.01	6.04	0.14	0.00	-0.20
10≤α<15	-28.97	-0.36	0.00	28.39	0.32	0.00	1.53	0.02	0.00	-0.20
15≤α<40	-6.06	0.61	0.00	7.39	-0.66	0.00	0.03	-0.01	0.00	-0.20
40≤α<85	-1.27	0.02	0.00	550.23	18.68	0.13	0.02	0.00	0.00	-4.80

Regression Coefficients for Spectral Class 104 - σ=20000										
	X_1	X_2	X_3	X_4	X_5	X6	X_7	X_8	X_9	Y
α<0.4	3.12	-0.03	0.00	0.12	0.01	0.00	-14.68	0.90	0.00	-0.20
0.4≤α<0.7	-22.23	0.52	0.00	18.04	-0.37	0.00	377.93	-7.40	0.03	-0.10
0.7≤α<1.0	4.70	-0.24	0.00	-0.91	0.17	0.00	-60.56	3.10	-0.02	-0.10
1.0≤α<3.0	-1.12	0.15	0.00	2.65	-0.09	0.00	-14.25	-0.06	0.00	-0.20
3.0≤α<4.0	-0.18	0.00	0.00	1.46	0.04	0.00	-5.50	-0.08	0.00	-0.10
4.0≤α<6.0	-4.14	-0.09	0.00	3.09	0.10	0.00	3.87	-0.07	0.00	-0.30
6.0≤α<8.0	-12.40	-0.01	0.00	9.17	0.02	0.00	5.57	-0.05	0.00	-0.40
8.0≤α<10	-25.51	0.04	0.00	22.49	-0.04	0.00	4.47	-0.02	0.00	-0.26
10≤α<15	-25.77	0.18	0.00	24.51	-0.20	0.00	2.69	0.00	0.00	-0.40
15≤α<40	1.46	0.02	0.00	0.71	-0.14	0.00	-0.10	0.00	0.00	-4.80
40≤α<85	-1.15	0.03	0.00	711.24	0.99	0.23	0.02	0.00	0.00	-4.80

Regression Coefficients for Spectral Class 105 - σ=20000										
	X_1	X_2	X_3	X_4	X_5	X6	X_7	X_8	X_9	Y
α<0.4	1.50	0.02	0.00	0.34	0.00	0.00	-58.48	1.90	-0.01	-0.30
0.4≤α<0.7	0.27	0.05	0.00	1.03	-0.02	0.00	31.86	0.05	0.00	-0.20
0.7≤α<1.0	1.69	0.05	0.00	0.27	-0.01	0.00	-21.17	0.41	0.00	-0.30
1.0≤α<3.0	-2.85	0.17	0.00	3.08	-0.09	0.00	-1.92	-0.20	0.00	-0.20
3.0≤α<4.0	59.15	1.00	-0.01	-27.12	-0.44	0.00	-96.34	-1.68	0.01	-0.50
4.0≤α<6.0	3.12	-0.07	0.00	-1.05	0.06	0.00	-3.02	0.03	0.00	-0.60
6.0≤α<8.0	-25.66	0.32	0.00	17.27	-0.19	0.00	10.94	-0.16	0.00	-0.50
8.0≤α<10	-68.65	-0.08	0.00	62.26	0.09	0.00	7.30	-0.01	0.00	-0.17
10≤α<15	-17.14	-0.33	0.00	17.34	0.30	0.00	0.69	0.02	0.00	-0.20
15≤α<40	-6.24	0.19	0.00	7.50	-0.21	0.00	0.01	0.00	0.00	-0.20
40≤α<85	-2.00	0.02	0.00	829.51	9.00	-0.01	0.03	0.00	0.00	-4.80

Regression Coefficients for Spectral Class 106 - σ=20000										
	X_1	X_2	X_3	X_4	X_5	X6	X_7	X_8	X_9	Y
α<0.4	2.37	-0.03	0.00	0.71	0.01	0.00	-165.18	5.25	-0.01	-0.20
0.4≤α<0.7	1.60	0.02	0.00	0.99	-0.01	0.00	-19.38	1.55	-0.01	-0.20
0.7≤α<1.0	3.01	0.02	0.00	0.08	-0.01	0.00	-21.82	0.48	0.00	-0.50
1.0≤α<3.0	1.09	0.12	0.00	1.32	-0.07	0.00	-13.97	-0.08	0.00	-0.20
3.0≤α<4.0	0.26	0.10	0.00	1.41	-0.05	0.00	-6.11	-0.16	0.00	-0.20
4.0≤α<6.0	-7.53	-0.05	0.00	6.32	0.06	0.00	1.11	-0.06	0.00	-0.30
6.0≤α<8.0	-54.49	0.13	0.00	42.21	-0.09	0.00	15.31	-0.09	0.00	-0.30
8.0≤α<10	5.50	-0.09	0.00	-5.41	0.06	0.00	1.07	0.02	0.00	-0.26
10≤α<15	-8.43	0.79	0.00	8.52	-0.78	0.00	1.12	-0.03	0.00	-0.20
15≤α<40	-0.01	-0.08	0.00	2.34	0.09	0.00	-0.09	0.00	0.00	-0.20
40≤α<85	-1.56	0.02	0.00	1,121.34	7.56	0.08	0.03	0.00	0.00	-4.80

Regression Coefficients for Spectral Class 107 - σ=20000										
	X_1	X_2	X_3	X_4	X_5	X6	X_7	X_8	X_9	Y
α<0.4	-0.21	0.05	0.00	0.52	-0.01	0.00	-162.77	6.26	-0.02	-0.40
0.4≤α<0.7	6.22	-0.07	0.00	-1.68	0.04	0.00	-240.15	6.18	-0.02	-0.30
0.7≤α<1.0	1.43	0.08	0.00	-0.01	-0.03	0.00	-25.56	0.44	0.00	-0.20
1.0≤α<3.0	-5.82	0.24	0.00	4.25	-0.12	0.00	22.69	-0.74	0.00	-0.20
3.0≤α<4.0	0.01	0.24	0.00	1.90	-0.16	0.00	-8.82	-0.16	0.00	-0.20
4.0≤α<6.0	-37.22	0.66	0.00	20.97	-0.34	0.00	30.84	-0.61	0.00	-0.50
6.0≤α<8.0	-26.36	-0.24	0.00	23.50	0.20	0.00	3.56	0.04	0.00	-0.20
8.0≤α<10	-25.32	-1.32	0.01	21.63	1.19	-0.01	4.87	0.12	0.00	-0.20
10≤α<15	-11.97	0.21	0.00	11.67	-0.20	0.00	1.42	-0.01	0.00	-0.50
15≤α<40	-6.57	0.21	0.00	7.99	-0.21	0.00	0.01	0.00	0.00	-0.20
40≤α<85	-1.56	0.04	0.00	525.97	14.80	-0.03	0.02	0.00	0.00	-4.80

Regression Coefficients for Spectral Class 108 - σ=20000										
	X_1	X_2	X_3	X_4	X_5	X6	X_7	X_8	X_9	Y
α<0.4	3.03	-0.02	0.00	-0.17	0.01	0.00	-402.67	9.13	-0.03	-0.20
0.4≤α<0.7	19.82	-0.38	0.00	-12.44	0.28	0.00	-346.43	8.72	-0.04	-0.10
0.7≤α<1.0	4.95	-0.02	0.00	-0.97	0.01	0.00	-60.93	1.22	0.00	-0.40
1.0≤α<3.0	1.60	0.07	0.00	0.24	-0.02	0.00	-18.03	0.06	0.00	-0.30
3.0≤α<4.0	-0.56	0.02	0.00	0.89	0.03	0.00	-1.29	-0.13	0.00	-0.10
4.0≤α<6.0	-5.06	-0.08	0.00	3.40	0.09	0.00	4.97	-0.03	0.00	-0.30
6.0≤α<8.0	-60.18	-0.05	0.00	55.12	0.07	0.00	7.84	-0.03	0.00	-0.10
8.0≤α<10	-1.35	-0.63	0.00	2.10	0.56	0.00	0.54	0.07	0.00	-0.20
10≤α<15	-15.94	0.10	0.00	15.44	-0.09	0.00	1.80	-0.01	0.00	-0.50
15≤α<40	-2.49	0.04	0.00	3.95	-0.03	0.00	-0.07	0.00	0.00	-0.20
40≤α<85	-14.15	-0.35	0.00	19.19	0.50	0.01	0.07	0.00	0.00	-0.30

Regression Coefficients for Spectral Class 109 - σ=20000										
	X_1	X_2	X_3	X_4	X_5	X6	X_7	X_8	X_9	Y
α<0.4	4.40	-0.03	0.00	0.09	0.01	0.00	-31.09	0.23	0.00	-0.20
0.4≤α<0.7	-1.05	0.09	0.00	1.99	-0.04	0.00	201.70	-3.81	0.02	-0.30
0.7≤α<1.0	3.37	-0.15	0.00	0.88	0.10	0.00	-28.00	1.86	-0.01	-0.10
1.0≤α<3.0	3.77	0.04	0.00	0.28	-0.02	0.00	-13.09	0.05	0.00	-0.30
3.0≤α<4.0	-2.92	-0.07	0.00	6.06	0.06	0.00	-10.37	0.12	0.00	-0.10
4.0≤α<6.0	-12.73	0.17	0.00	11.23	-0.11	0.00	0.07	-0.04	0.00	-0.30
6.0≤α<8.0	-25.90	0.21	0.00	17.39	-0.11	0.00	10.62	-0.11	0.00	-0.50
8.0≤α<10	-7.58	-0.23	0.00	5.20	0.24	0.00	3.70	0.00	0.00	-0.30
10≤α<15	21.83	-0.15	0.00	-18.10	0.14	0.00	-2.39	0.01	0.00	-0.50
15≤α<40	-0.61	-0.02	0.00	13.91	0.01	0.00	0.14	0.00	0.00	-4.80
40≤α<85	-46.92	2.42	-0.01	62.51	-3.03	0.02	0.08	-0.01	0.00	-0.20

Regression Coefficients for Spectral Class 110 - σ=20000										
	X_1	X_2	X_3	X_4	X_5	X6	X_7	X_8	X_9	Y
α<0.4	3.52	-0.02	0.00	0.37	0.01	0.00	-120.86	2.00	0.00	-0.20
0.4≤α<0.7	5.41	-0.06	0.00	-0.45	0.02	0.00	-120.48	3.28	-0.01	-0.30
0.7≤α<1.0	1.60	0.21	0.00	1.69	-0.15	0.00	1.13	-1.03	0.01	-0.10
1.0≤α<3.0	2.49	0.05	0.00	0.65	-0.02	0.00	-5.11	-0.04	0.00	-0.30
3.0≤α<4.0	-1.34	-0.03	0.00	4.14	0.03	0.00	-4.08	0.01	0.00	-0.10
4.0≤α<6.0	1.75	0.01	0.00	1.30	0.00	0.00	-4.78	-0.01	0.00	-0.20
6.0≤α<8.0	-10.10	0.16	0.00	9.33	-0.10	0.00	0.31	-0.07	0.00	-0.40
8.0≤α<10	-3.91	-0.02	0.00	5.05	0.04	0.00	-1.66	-0.03	0.00	-0.20
10≤α<15	-7.81	-0.25	0.00	7.16	0.24	0.00	0.13	0.00	0.00	-0.17
15≤α<40	-1.76	0.05	0.00	1.42	-0.15	0.00	0.17	0.00	0.00	-2.60
40≤α<85	-7.36	0.51	-0.01	11.54	-0.68	0.02	0.02	0.00	0.00	-0.30

Regression Coefficients for Spectral Class 111 - σ=20000										
	X_1	X_2	X_3	X_4	X_5	X6	X_7	X_8	X_9	Y
α<0.4	4.10	-0.02	0.00	0.20	0.01	0.00	-24.98	-0.27	0.00	-0.20
0.4≤α<0.7	2.76	0.01	0.00	0.44	-0.01	0.00	63.40	-1.08	0.01	-0.40
0.7≤α<1.0	2.40	-0.05	0.00	1.51	0.03	0.00	-9.34	0.76	0.00	-0.10
1.0≤α<3.0	3.50	0.03	0.00	0.38	-0.02	0.00	-5.10	0.01	0.00	-0.30
3.0≤α<4.0	-3.75	-0.06	0.00	6.71	0.05	0.00	-2.57	0.05	0.00	-0.10
4.0≤α<6.0	-2.34	0.06	0.00	5.56	-0.05	0.00	-3.49	0.00	0.00	-0.10
6.0≤α<8.0	-3.89	0.07	0.00	5.77	-0.05	0.00	-1.62	-0.02	0.00	-0.30
8.0≤α<10	-13.27	0.08	0.00	13.90	-0.06	0.00	-0.36	-0.02	0.00	-0.26
10≤α<15	5.37	-2.58	0.01	-3.76	2.47	-0.01	-1.50	0.13	0.00	-0.18
15≤α<40	46.26	-0.06	0.00	-50.59	0.06	0.00	-0.47	0.00	0.00	-0.20
40≤α<85	22.47	1.27	-0.02	-31.18	-1.78	0.03	-0.10	-0.01	0.00	-0.30

Regression Coefficients for Spectral Class 112 - σ=20000										
	X_1	X_2	X_3	X_4	X_5	X6	X_7	X_8	X_9	Y
α<0.4	3.36	-0.01	0.00	0.07	0.00	0.00	-65.53	1.98	0.00	-0.40
0.4≤α<0.7	-1.42	0.10	0.00	1.26	-0.03	0.00	229.71	-4.19	0.02	-0.40
0.7≤α<1.0	5.06	-0.15	0.00	-1.08	0.11	0.00	-59.30	2.54	-0.01	-0.10
1.0≤α<3.0	-0.71	0.16	0.00	2.49	-0.09	0.00	-13.21	-0.12	0.00	-0.20
3.0≤α<4.0	1.87	0.05	0.00	0.10	-0.01	0.00	-8.04	-0.10	0.00	-0.20
4.0≤α<6.0	-8.77	-0.07	0.00	6.48	0.08	0.00	5.88	-0.09	0.00	-0.30
6.0≤α<8.0	-12.84	-0.13	0.00	9.42	0.10	0.00	6.03	0.00	0.00	-0.40
8.0≤α<10	-26.88	-0.67	0.00	24.37	0.58	0.00	4.20	0.08	0.00	-0.20
10≤α<15	-0.70	0.33	0.00	2.30	-0.34	0.00	0.04	0.00	0.00	-0.17
15≤α<40	-8.29	0.14	0.00	10.88	-0.15	0.00	0.02	0.00	0.00	-0.20
40≤α<85	-18.72	-0.27	-0.01	24.19	0.38	0.01	0.05	0.00	0.00	-0.20

Regression Coefficients for Spectral Class 113 - σ=20000

	X_1	X_2	X_3	X_4	X_5	X6	X_7	X_8	X_9	Y
α<0.4	2.19	0.00	0.00	0.42	0.00	0.00	-38.28	0.66	0.00	-0.20
0.4≤α<0.7	1.01	0.03	0.00	0.50	-0.01	0.00	72.40	-1.11	0.01	-0.40
0.7≤α<1.0	1.17	0.05	0.00	0.98	-0.02	0.00	-8.58	0.24	0.00	-0.20
1.0≤α<3.0	0.30	0.09	0.00	1.52	-0.05	0.00	-7.50	-0.03	0.00	-0.20
3.0≤α<4.0	1.18	0.01	0.00	0.84	0.01	0.00	-6.23	0.01	0.00	-0.10
4.0≤α<6.0	-2.96	-0.03	0.00	3.59	0.05	0.00	-1.64	0.00	0.00	-0.20
6.0≤α<8.0	-16.82	0.18	0.00	12.68	-0.11	0.00	4.70	-0.08	0.00	-0.40
8.0≤α<10	-40.40	0.15	0.00	34.86	-0.10	0.00	5.59	-0.04	0.00	-0.25
10≤α<15	-25.06	0.53	0.00	23.91	-0.50	0.00	1.24	-0.03	0.00	-0.17
15≤α<40	-5.90	-0.09	0.00	6.55	0.08	0.00	0.00	0.00	0.00	-0.20
40≤α<85	7.71	0.88	-0.01	-14.38	-1.41	0.01	-0.02	0.00	0.00	-0.40

Regression Coefficients for Spectral Class 114 - σ=20000

	X_1	X_2	X_3	X_4	X_5	X6	X_7	X_8	X_9	Y
α<0.4	2.07	0.01	0.00	0.31	0.00	0.00	-3.42	0.43	0.00	-0.20
0.4≤α<0.7	-4.57	0.16	0.00	3.62	-0.07	0.00	202.40	-3.74	0.02	-0.20
0.7≤α<1.0	4.25	-0.19	0.00	-1.07	0.15	0.00	-51.85	2.60	-0.01	-0.10
1.0≤α<3.0	-1.11	0.12	0.00	1.79	-0.05	0.00	-6.47	-0.13	0.00	-0.30
3.0≤α<4.0	1.78	0.02	0.00	-0.61	0.02	0.00	-2.47	-0.10	0.00	-0.10
4.0≤α<6.0	1.18	-0.06	0.00	-0.37	0.06	0.00	0.71	-0.01	0.00	-0.50
6.0≤α<8.0	-15.58	0.17	0.00	11.74	-0.10	0.00	5.92	-0.08	0.00	-0.40
8.0≤α<10	-59.81	-0.01	0.00	54.73	0.02	0.00	6.30	-0.02	0.00	-0.17
10≤α<15	0.45	-0.33	0.00	1.11	0.31	0.00	-0.36	0.02	0.00	-0.20
15≤α<40	-10.34	0.09	0.00	12.01	-0.10	0.00	0.09	0.00	0.00	-0.20
40≤α<85	-28.16	0.09	0.00	35.83	-0.05	0.00	0.07	0.00	0.00	-0.20

Regression Coefficients for Spectral Class 115 - σ=20000

	X_1	X_2	X_3	X_4	X_5	X6	X_7	X_8	X_9	Y
α<0.4	3.35	-0.04	0.00	0.38	0.01	0.00	-44.90	1.66	0.00	-0.20
0.4≤α<0.7	-2.30	0.11	0.00	2.26	-0.04	0.00	222.18	-3.91	0.02	-0.30
0.7≤α<1.0	3.76	-0.26	0.00	0.22	0.19	0.00	-44.55	3.02	-0.02	-0.10
1.0≤α<3.0	1.67	0.10	0.00	1.31	-0.07	0.00	-15.27	-0.02	0.00	-0.20
3.0≤α<4.0	1.31	0.16	0.00	1.34	-0.10	0.00	-11.83	-0.09	0.00	-0.20
4.0≤α<6.0	-20.65	0.02	0.00	17.68	0.01	0.00	2.58	-0.05	0.00	-0.20
6.0≤α<8.0	-29.91	0.03	0.00	21.00	0.00	0.00	11.18	-0.07	0.00	-0.40
8.0≤α<10	-41.54	0.31	0.00	33.73	-0.26	0.00	8.91	-0.07	0.00	-0.30
10≤α<15	26.30	0.55	0.00	-24.36	-0.55	0.00	-0.86	-0.02	0.00	-0.17
15≤α<40	-19.51	0.15	0.00	22.69	-0.16	0.00	0.18	0.00	0.00	-0.20
40≤α<85	-17.22	0.34	-0.01	25.86	-0.44	0.01	0.05	0.00	0.00	-0.30

Regression Coefficients for Spectral Class 116 - σ=20000

	X_1	X_2	X_3	X_4	X_5	X6	X_7	X_8	X_9	Y
α<0.4	6.05	-0.07	0.00	-2.70	0.04	0.00	-389.78	9.90	-0.03	-0.20
0.4≤α<0.7	-6.17	0.20	0.00	1.60	-0.04	0.00	396.35	-7.92	0.03	-0.40
0.7≤α<1.0	11.93	-0.24	0.00	-8.38	0.20	0.00	-114.62	3.57	-0.02	-0.10
1.0≤α<3.0	-7.28	0.21	0.00	3.66	-0.08	0.00	18.89	-0.88	0.00	-0.30
3.0≤α<4.0	1.16	0.07	0.00	-1.50	-0.03	0.00	4.68	-0.25	0.00	-0.20
4.0≤α<6.0	-17.64	0.16	0.00	11.21	-0.11	0.00	18.60	-0.09	0.00	-0.30
6.0≤α<8.0	14.39	0.20	0.00	-6.90	-0.10	0.00	-5.18	-0.13	0.00	-0.80
8.0≤α<10	-56.86	0.26	0.00	59.64	-0.25	0.00	-2.18	-0.01	0.00	-0.10
10≤α<15	-253.62	8.79	-0.05	241.78	-8.41	0.04	13.02	-0.42	0.00	-0.17
15≤α<40	-0.90	0.03	0.00	12.73	-0.05	0.00	0.04	0.00	0.00	-4.80
40≤α<85	-4.00	1.20	-0.02	5.72	-1.90	0.03	0.03	-0.01	0.00	-0.40

Regression Coefficients for Spectral Class 117 - σ=20000										
	X_1	X_2	X_3	X_4	X_5	X6	X_7	X_8	X_9	Y
$\alpha<0.4$	2.54	-0.03	0.00	0.18	0.01	0.00	-60.17	3.38	-0.01	-0.20
$0.4\leq\alpha<0.7$	-5.09	0.17	0.00	2.81	-0.06	0.00	308.50	-5.64	0.02	-0.30
$0.7\leq\alpha<1.0$	6.15	-0.25	0.00	-2.38	0.19	0.00	-77.06	3.50	-0.02	-0.10
$1.0\leq\alpha<3.0$	-3.60	0.21	0.00	3.84	-0.12	0.00	-9.59	-0.27	0.00	-0.20
$3.0\leq\alpha<4.0$	0.98	0.13	0.00	-0.15	-0.06	0.00	-4.15	-0.25	0.00	-0.20
$4.0\leq\alpha<6.0$	-8.33	-0.15	0.00	4.85	0.12	0.00	9.20	-0.02	0.00	-0.40
$6.0\leq\alpha<8.0$	-1.90	-0.20	0.00	1.18	0.16	0.00	4.04	0.01	0.00	-0.30
$8.0\leq\alpha<10$	-2.89	-1.06	0.01	4.50	0.90	0.00	0.14	0.15	0.00	-0.20
$10\leq\alpha<15$	-21.93	0.16	0.00	22.71	-0.17	0.00	0.87	0.01	0.00	-0.17
$15\leq\alpha<40$	-4.27	0.11	0.00	6.66	-0.12	0.00	0.03	0.00	0.00	-0.40
$40\leq\alpha<85$	-0.12	0.01	0.00	6.02	8.36	0.24	0.00	0.00	0.00	-4.80

Regression Coefficients for Spectral Class 118 - σ=20000										
	X_1	X_2	X_3	X_4	X_5	X6	X_7	X_8	X_9	Y
$\alpha<0.4$	2.99	-0.03	0.00	-0.28	0.02	0.00	-82.63	3.26	-0.01	-0.20
$0.4\leq\alpha<0.7$	-5.58	0.18	0.00	2.81	-0.06	0.00	321.73	-6.03	0.02	-0.30
$0.7\leq\alpha<1.0$	6.50	-0.18	0.00	-2.96	0.14	0.00	-78.02	2.96	-0.01	-0.10
$1.0\leq\alpha<3.0$	-4.60	0.22	0.00	4.21	-0.12	0.00	-8.80	-0.26	0.00	-0.20
$3.0\leq\alpha<4.0$	3.74	0.10	0.00	-2.69	-0.03	0.00	-3.71	-0.24	0.00	-0.20
$4.0\leq\alpha<6.0$	-5.42	-0.22	0.00	3.01	0.19	0.00	8.46	-0.01	0.00	-0.30
$6.0\leq\alpha<8.0$	7.09	-0.11	0.00	-5.84	0.10	0.00	1.44	-0.01	0.00	-0.20
$8.0\leq\alpha<10$	-5.49	-1.30	0.01	6.91	1.13	-0.01	0.16	0.17	0.00	-0.20
$10\leq\alpha<15$	-15.94	-0.09	0.00	17.01	0.07	0.00	0.48	0.02	0.00	-0.20
$15\leq\alpha<40$	-4.28	0.13	0.00	5.95	-0.13	0.00	-0.04	0.00	0.00	-0.20
$40\leq\alpha<85$	-0.82	0.00	0.00	223.70	14.34	0.12	0.01	0.00	0.00	-4.80

Regression Coefficients for Spectral Class 119 - σ=20000										
	X_1	X_2	X_3	X_4	X_5	X6	X_7	X_8	X_9	Y
$\alpha<0.4$	2.90	-0.02	0.00	0.37	0.01	0.00	-61.90	1.54	0.00	-0.20
$0.4\leq\alpha<0.7$	0.42	0.05	0.00	0.79	-0.01	0.00	125.46	-2.05	0.01	-0.40
$0.7\leq\alpha<1.0$	2.41	-0.08	0.00	0.83	0.05	0.00	-31.21	1.59	-0.01	-0.10
$1.0\leq\alpha<3.0$	0.89	0.10	0.00	1.50	-0.06	0.00	-11.49	-0.03	0.00	-0.20
$3.0\leq\alpha<4.0$	3.53	0.13	0.00	-0.67	-0.07	0.00	-10.26	-0.07	0.00	-0.20
$4.0\leq\alpha<6.0$	-11.89	0.00	0.00	10.63	0.02	0.00	1.13	-0.04	0.00	-0.20
$6.0\leq\alpha<8.0$	-20.40	0.10	0.00	14.85	-0.05	0.00	6.92	-0.08	0.00	-0.40
$8.0\leq\alpha<10$	-44.88	0.04	0.00	38.41	-0.02	0.00	7.06	-0.03	0.00	-0.25
$10\leq\alpha<15$	3.17	-0.12	0.00	-2.47	0.09	0.00	-0.13	0.02	0.00	-0.50
$15\leq\alpha<40$	-3.12	0.24	0.00	4.55	-0.26	0.00	-0.02	0.00	0.00	-0.20
$40\leq\alpha<85$	-1.17	0.03	0.00	703.21	-5.46	0.23	0.02	0.00	0.00	-4.80

Regression Coefficients for Spectral Class 120 - σ=20000										
	X_1	X_2	X_3	X_4	X_5	X6	X_7	X_8	X_9	Y
$\alpha<0.4$	1.80	-0.02	0.00	0.66	0.01	0.00	-148.74	5.35	-0.02	-0.20
$0.4\leq\alpha<0.7$	-1.25	0.08	0.00	2.07	-0.04	0.00	64.51	-0.34	0.00	-0.20
$0.7\leq\alpha<1.0$	1.59	0.09	0.00	0.66	-0.05	0.00	-22.73	0.28	0.00	-0.20
$1.0\leq\alpha<3.0$	0.05	0.11	0.00	1.23	-0.05	0.00	-10.39	-0.19	0.00	-0.30
$3.0\leq\alpha<4.0$	0.41	0.07	0.00	0.78	-0.02	0.00	-5.73	-0.16	0.00	-0.20
$4.0\leq\alpha<6.0$	-10.03	-0.12	0.00	7.20	0.12	0.00	6.15	-0.05	0.00	-0.30
$6.0\leq\alpha<8.0$	-29.23	-0.07	0.00	22.50	0.06	0.00	9.89	-0.02	0.00	-0.30
$8.0\leq\alpha<10$	-19.72	-0.99	0.00	17.82	0.86	0.00	3.44	0.13	0.00	-0.20
$10\leq\alpha<15$	28.35	-0.16	0.00	-25.82	0.13	0.00	-1.06	0.02	0.00	-0.10
$15\leq\alpha<40$	-11.10	0.09	0.00	13.44	-0.09	0.00	0.06	0.00	0.00	-0.20
$40\leq\alpha<85$	-0.79	0.01	0.00	459.19	16.79	0.04	0.01	0.00	0.00	-4.80

Regression Coefficients for Spectral Class 121 - σ=20000										
	X_1	X_2	X_3	X_4	X_5	X6	X_7	X_8	X_9	Y
$\alpha<0.4$	2.03	-0.01	0.00	0.05	0.00	0.00	-140.26	5.97	-0.02	-0.60
$0.4\le\alpha<0.7$	-2.13	0.11	0.00	1.10	-0.03	0.00	193.04	-3.12	0.01	-0.40
$0.7\le\alpha<1.0$	1.16	0.09	0.00	0.33	-0.02	0.00	-21.46	-0.09	0.00	-0.40
$1.0\le\alpha<3.0$	-5.33	0.24	0.00	4.48	-0.13	0.00	-2.36	-0.49	0.00	-0.20
$3.0\le\alpha<4.0$	2.58	0.17	0.00	-1.88	-0.08	0.00	-0.18	-0.44	0.00	-0.20
$4.0\le\alpha<6.0$	3.87	-0.50	0.00	-2.72	0.33	0.00	2.11	0.19	0.00	-0.40
$6.0\le\alpha<8.0$	-33.56	0.06	0.00	28.79	-0.09	0.00	8.19	0.02	0.00	-0.20
$8.0\le\alpha<10$	4.24	-1.99	0.01	-2.42	1.72	-0.01	0.00	0.28	0.00	-0.20
$10\le\alpha<15$	10.88	-0.17	0.00	-8.35	0.16	0.00	-0.81	0.02	0.00	-0.10
$15\le\alpha<40$	-12.97	-0.09	0.00	15.29	0.11	0.00	0.09	0.00	0.00	-0.20
$40\le\alpha<85$	-0.38	-0.03	0.00	156.12	39.40	-0.13	0.00	0.00	0.00	-4.80

Regression Coefficients for Spectral Class 122 - σ=20000										
	X_1	X_2	X_3	X_4	X_5	X6	X_7	X_8	X_9	Y
$\alpha<0.4$	1.34	0.02	0.00	0.00	0.00	0.00	-250.89	6.23	-0.02	-2.40
$0.4\le\alpha<0.7$	-2.45	0.13	0.00	1.70	-0.05	0.00	95.76	-1.04	0.00	-0.20
$0.7\le\alpha<1.0$	8.43	0.00	0.00	-5.45	0.02	0.00	-78.92	1.66	-0.01	-0.10
$1.0\le\alpha<3.0$	-6.12	0.23	0.00	4.28	-0.11	0.00	9.21	-0.64	0.00	-0.20
$3.0\le\alpha<4.0$	1.23	0.10	0.00	-1.17	-0.03	0.00	4.77	-0.38	0.00	-0.20
$4.0\le\alpha<6.0$	26.26	-0.96	0.00	-20.67	0.77	0.00	-4.95	0.23	0.00	-0.20
$6.0\le\alpha<8.0$	-53.08	0.56	0.00	45.74	-0.50	0.00	10.89	-0.09	0.00	-0.20
$8.0\le\alpha<10$	-85.50	0.83	0.00	75.47	-0.76	0.00	11.53	-0.07	0.00	-0.25
$10\le\alpha<15$	-15.63	0.40	0.00	16.68	-0.39	0.00	0.35	-0.01	0.00	-0.17
$15\le\alpha<40$	-10.26	-0.03	0.00	12.01	0.05	0.00	0.05	0.00	0.00	-0.20
$40\le\alpha<85$	-0.57	0.00	0.00	48.91	30.47	-0.02	0.01	0.00	0.00	-4.80

Regression Coefficients for Spectral Class 123 - σ=20000										
	X_1	X_2	X_3	X_4	X_5	X6	X_7	X_8	X_9	Y
$\alpha<0.4$	2.17	0.01	0.00	0.20	0.00	0.00	-100.98	1.62	0.00	-0.30
$0.4\le\alpha<0.7$	3.72	-0.03	0.00	-0.40	0.01	0.00	-90.18	2.38	-0.01	-0.30
$0.7\le\alpha<1.0$	2.46	0.01	0.00	0.00	0.00	0.00	-16.69	0.49	0.00	-0.60
$1.0\le\alpha<3.0$	0.70	0.07	0.00	1.04	-0.03	0.00	-5.55	0.00	0.00	-0.20
$3.0\le\alpha<4.0$	-0.24	0.00	0.00	1.83	0.02	0.00	-3.25	0.01	0.00	-0.10
$4.0\le\alpha<6.0$	0.54	-0.02	0.00	0.80	0.04	0.00	-1.61	-0.01	0.00	-0.20
$6.0\le\alpha<8.0$	-10.81	0.18	0.00	9.47	-0.12	0.00	1.68	-0.06	0.00	-0.30
$8.0\le\alpha<10$	-35.60	-0.05	0.00	33.32	0.07	0.00	2.19	-0.01	0.00	-0.17
$10\le\alpha<15$	-10.74	-0.77	0.00	10.61	0.75	0.00	-0.03	0.03	0.00	-0.18
$15\le\alpha<40$	-2.94	-0.04	0.00	3.90	0.05	0.00	0.12	0.00	0.00	-1.80
$40\le\alpha<85$	7.45	0.78	0.00	-13.98	-1.22	0.01	-0.01	0.00	0.00	-0.40

Regression Coefficients for Spectral Class 201 - σ=20000										
	X_1	X_2	X_3	X_4	X_5	X6	X_7	X_8	X_9	Y
α<0.4	2.14	0.00	0.00	0.35	0.00	0.00	-174.91	4.80	-0.01	-0.30
0.4≤α<0.7	3.23	-0.01	0.00	-0.12	0.01	0.00	-80.44	2.72	-0.01	-0.30
0.7≤α<1.0	3.69	0.01	0.00	-0.41	0.00	0.00	-42.89	0.87	0.00	-0.30
1.0≤α<3.0	-1.93	0.17	0.00	2.77	-0.09	0.00	-3.05	-0.26	0.00	-0.20
3.0≤α<4.0	-1.17	0.00	0.00	2.79	0.03	0.00	-7.34	-0.04	0.00	-0.10
4.0≤α<6.0	-23.51	0.29	0.00	16.98	-0.17	0.00	11.57	-0.23	0.00	-0.30
6.0≤α<8.0	-16.64	-0.10	0.00	12.30	0.08	0.00	5.59	0.00	0.00	-0.40
8.0≤α<10	-85.17	1.32	-0.01	73.07	-1.14	0.00	13.04	-0.19	0.00	-0.25
10≤α<15	76.72	-2.66	0.01	-72.59	2.52	-0.01	-3.52	0.14	0.00	-0.17
15≤α<40	0.59	0.02	0.00	4.95	-0.10	0.00	-0.05	0.00	0.00	-4.80
40≤α<85	3.00	0.75	-0.01	-4.93	-1.03	0.02	-0.01	0.00	0.00	-0.30

Regression Coefficients for Spectral Class 202 - σ=20000										
	X_1	X_2	X_3	X_4	X_5	X6	X_7	X_8	X_9	Y
α<0.4	2.18	-0.04	0.00	0.77	0.01	0.00	-194.47	7.68	-0.03	-0.20
0.4≤α<0.7	0.16	0.05	0.00	1.18	-0.02	0.00	48.28	0.24	0.00	-0.30
0.7≤α<1.0	7.04	-0.11	0.00	-2.86	0.08	0.00	-58.71	2.03	-0.01	-0.10
1.0≤α<3.0	1.08	0.14	0.00	1.24	-0.08	0.00	-20.03	-0.13	0.00	-0.20
3.0≤α<4.0	0.63	0.13	0.00	1.10	-0.07	0.00	-12.93	-0.18	0.00	-0.20
4.0≤α<6.0	-18.04	-0.16	0.00	11.18	0.12	0.00	11.12	0.01	0.00	-0.40
6.0≤α<8.0	-34.49	-0.12	0.00	24.86	0.09	0.00	14.42	0.02	0.00	-0.30
8.0≤α<10	2.46	0.69	0.00	-2.55	-0.54	0.00	2.69	-0.16	0.00	-0.50
10≤α<15	26.52	0.90	-0.01	-21.31	-0.88	0.01	-2.56	-0.03	0.00	-0.17
15≤α<40	-1.06	-0.12	0.00	2.65	0.13	0.00	-0.05	0.00	0.00	-0.20
40≤α<85	-0.41	-0.05	0.00	490.72	47.67	-0.46	0.00	0.00	0.00	-4.80

Regression Coefficients for Spectral Class 203 - σ=20000										
	X_1	X_2	X_3	X_4	X_5	X6	X_7	X_8	X_9	Y
α<0.4	1.26	0.01	0.00	0.34	0.00	0.00	-743.06	18.13	-0.07	-0.40
0.4≤α<0.7	19.21	-0.36	0.00	-6.28	0.14	0.00	-877.25	20.51	-0.08	-0.30
0.7≤α<1.0	3.43	0.42	0.00	-2.03	-0.27	0.00	30.47	-2.94	0.02	-0.10
1.0≤α<3.0	12.68	-0.14	0.00	-7.05	0.12	0.00	-31.57	0.33	0.00	-0.20
3.0≤α<4.0	2.68	0.06	0.00	-1.41	0.00	0.00	-2.64	-0.21	0.00	-0.10
4.0≤α<6.0	-55.81	0.88	0.00	39.17	-0.58	0.00	30.77	-0.57	0.00	-0.30
6.0≤α<8.0	-44.40	0.36	0.00	35.40	-0.28	0.00	11.28	-0.10	0.00	-0.30
8.0≤α<10	-32.69	-0.78	0.00	29.26	0.68	0.00	4.27	0.10	0.00	-0.20
10≤α<15	2.65	1.42	-0.01	-1.51	-1.36	0.01	-0.17	-0.07	0.00	-0.20
15≤α<40	-9.31	-0.09	0.00	10.97	0.10	0.00	0.05	0.00	0.00	-0.20
40≤α<85	-1.80	0.05	0.00	770.22	25.72	-0.34	0.03	0.00	0.00	-4.80

Regression Coefficients for Spectral Class 204 - σ=20000										
	X_1	X_2	X_3	X_4	X_5	X6	X_7	X_8	X_9	Y
α<0.4	3.81	-0.05	0.00	0.12	0.02	0.00	-63.94	1.93	0.00	-0.20
0.4≤α<0.7	-3.48	0.13	0.00	2.65	-0.05	0.00	268.38	-4.88	0.02	-0.30
0.7≤α<1.0	3.47	-0.12	0.00	0.38	0.08	0.00	-45.80	2.19	-0.01	-0.10
1.0≤α<3.0	2.54	0.07	0.00	0.58	-0.03	0.00	-19.86	0.04	0.00	-0.30
3.0≤α<4.0	-3.03	-0.04	0.00	5.11	0.05	0.00	-12.82	0.06	0.00	-0.10
4.0≤α<6.0	-25.78	0.26	0.00	18.62	-0.15	0.00	11.10	-0.22	0.00	-0.30
6.0≤α<8.0	-9.10	-0.17	0.00	5.22	0.13	0.00	6.33	-0.01	0.00	-0.50
8.0≤α<10	-3.37	-0.24	0.00	2.87	0.20	0.00	1.77	0.02	0.00	-0.25
10≤α<15	40.68	-1.70	0.01	-37.74	1.57	-0.01	-1.83	0.10	0.00	-0.17
15≤α<40	1.75	-0.18	0.00	-0.09	0.19	0.00	-0.09	0.00	0.00	-0.20
40≤α<85	-23.26	0.21	-0.01	29.86	-0.25	0.02	0.06	0.00	0.00	-0.20

Regression Coefficients for Spectral Class 205 - σ=20000										
	X_1	X_2	X_3	X_4	X_5	X6	X_7	X_8	X_9	Y
$\alpha<0.4$	2.12	-0.01	0.00	0.39	0.01	0.00	-245.73	6.52	-0.02	-0.20
$0.4\le\alpha<0.7$	3.66	-0.02	0.00	-0.39	0.01	0.00	-113.40	3.50	-0.01	-0.30
$0.7\le\alpha<1.0$	2.82	0.06	0.00	-0.27	-0.02	0.00	-23.70	0.33	0.00	-0.20
$1.0\le\alpha<3.0$	0.20	0.12	0.00	1.30	-0.06	0.00	-12.05	-0.10	0.00	-0.20
$3.0\le\alpha<4.0$	-0.90	0.03	0.00	1.44	0.01	0.00	-4.39	-0.06	0.00	-0.30
$4.0\le\alpha<6.0$	-5.73	-0.13	0.00	4.06	0.12	0.00	4.27	-0.02	0.00	-0.30
$6.0\le\alpha<8.0$	-11.30	0.03	0.00	7.39	-0.01	0.00	6.40	-0.05	0.00	-0.50
$8.0\le\alpha<10$	-75.70	1.57	-0.01	66.06	-1.36	0.01	10.87	-0.21	0.00	-0.25
$10\le\alpha<15$	2.07	0.03	0.00	-0.63	-0.04	0.00	-0.27	0.00	0.00	-0.50
$15\le\alpha<40$	-13.74	-0.01	0.00	15.91	0.01	0.00	0.10	0.00	0.00	-0.20
$40\le\alpha<85$	-22.14	-0.42	0.00	27.85	0.58	0.00	0.06	0.00	0.00	-0.20

Regression Coefficients for Spectral Class 206 - σ=20000										
	X_1	X_2	X_3	X_4	X_5	X6	X_7	X_8	X_9	Y
$\alpha<0.4$	3.77	-0.05	0.00	-0.29	0.02	0.00	-216.74	6.26	-0.02	-0.20
$0.4\le\alpha<0.7$	-1.88	0.10	0.00	1.71	-0.04	0.00	148.46	-2.09	0.01	-0.30
$0.7\le\alpha<1.0$	2.81	0.05	0.00	0.01	-0.02	0.00	-34.17	0.51	0.00	-0.30
$1.0\le\alpha<3.0$	0.26	0.13	0.00	1.55	-0.07	0.00	-22.46	-0.04	0.00	-0.20
$3.0\le\alpha<4.0$	0.48	0.01	0.00	0.30	0.02	0.00	-8.37	-0.05	0.00	-0.40
$4.0\le\alpha<6.0$	5.12	-0.43	0.00	-4.16	0.30	0.00	2.80	0.12	0.00	-0.40
$6.0\le\alpha<8.0$	4.90	-0.19	0.00	-3.16	0.12	0.00	0.61	0.06	0.00	-0.50
$8.0\le\alpha<10$	7.64	-1.08	0.01	-5.58	0.94	0.00	-0.17	0.14	0.00	-0.20
$10\le\alpha<15$	4.60	0.24	0.00	-1.82	-0.25	0.00	-0.88	0.00	0.00	-0.17
$15\le\alpha<40$	4.68	0.25	0.00	-3.50	-0.26	0.00	-0.13	0.00	0.00	-0.20
$40\le\alpha<85$	-0.01	-0.02	0.00	-145.02	23.91	0.08	0.00	0.00	0.00	-4.80

Regression Coefficients for Spectral Class 207 - σ=20000										
	X_1	X_2	X_3	X_4	X_5	X6	X_7	X_8	X_9	Y
$\alpha<0.4$	0.91	0.02	0.00	0.41	0.00	0.00	-917.94	21.93	-0.08	-0.40
$0.4\le\alpha<0.7$	24.56	-0.47	0.00	-8.29	0.18	0.00	-1126.75	26.02	-0.11	-0.30
$0.7\le\alpha<1.0$	4.53	0.59	0.00	-3.23	-0.39	0.00	48.56	-4.68	0.03	-0.10
$1.0\le\alpha<3.0$	15.97	-0.21	0.00	-9.23	0.16	0.00	-37.57	0.47	0.00	-0.20
$3.0\le\alpha<4.0$	1.04	0.04	0.00	-0.10	0.01	0.00	-1.08	-0.21	0.00	-0.10
$4.0\le\alpha<6.0$	-29.36	0.43	0.00	20.98	-0.27	0.00	15.51	-0.32	0.00	-0.30
$6.0\le\alpha<8.0$	-68.18	0.83	0.00	53.39	-0.63	0.00	18.32	-0.26	0.00	-0.30
$8.0\le\alpha<10$	-41.24	-0.55	0.00	37.39	0.47	0.00	4.31	0.07	0.00	-0.20
$10\le\alpha<15$	-7.95	0.43	0.00	7.87	-0.44	0.00	0.59	-0.01	0.00	-0.20
$15\le\alpha<40$	1.39	0.34	0.00	-0.51	-0.35	0.00	-0.11	0.00	0.00	-0.20
$40\le\alpha<85$	5.17	1.18	-0.02	-8.81	-1.63	0.03	-0.01	0.00	0.00	-0.30

Regression Coefficients for Spectral Class 208 - σ=20000										
	X_1	X_2	X_3	X_4	X_5	X6	X_7	X_8	X_9	Y
$\alpha<0.4$	-4.22	0.12	0.00	0.00	0.00	0.00	169.74	2.76	-0.02	-1.50
$0.4\le\alpha<0.7$	9.06	-0.06	0.00	-9.03	0.13	0.00	33.53	-0.01	0.00	-0.10
$0.7\le\alpha<1.0$	4.95	0.17	0.00	-5.47	-0.05	0.00	-78.72	1.02	0.00	-0.10
$1.0\le\alpha<3.0$	-8.33	0.28	0.00	3.03	-0.10	0.00	78.70	-1.72	0.01	-0.20
$3.0\le\alpha<4.0$	-6.23	-0.11	0.00	10.06	0.07	0.00	-27.92	0.39	0.00	-0.10
$4.0\le\alpha<6.0$	-255.10	3.43	-0.01	198.62	-2.63	0.01	102.80	-1.44	0.00	-0.20
$6.0\le\alpha<8.0$	119.95	-0.67	0.00	-103.91	0.55	0.00	-22.88	0.21	0.00	-0.10
$8.0\le\alpha<10$	-2.94	1.09	-0.01	-1.67	-0.84	0.01	5.62	-0.25	0.00	-0.26
$10\le\alpha<15$	98.84	-7.66	0.04	-93.96	7.31	-0.04	-5.08	0.40	0.00	-0.17
$15\le\alpha<40$	-1.91	-0.27	0.00	1.95	0.31	0.00	-0.07	0.00	0.00	-0.10
$40\le\alpha<85$	-10.33	1.06	-0.01	14.02	-1.62	0.02	0.06	0.00	0.00	-0.40

Regression Coefficients for Spectral Class 209 - σ=20000										
	X_1	X_2	X_3	X_4	X_5	X6	X_7	X_8	X_9	Y
α<0.4	1.44	0.04	0.00	-1.39	0.01	0.00	310.13	-5.60	0.03	-0.20
0.4≤α<0.7	-17.13	0.48	0.00	8.06	-0.21	0.00	638.41	-13.59	0.06	-0.20
0.7≤α<1.0	0.58	0.18	0.00	-0.33	-0.08	0.00	-49.99	-0.07	0.00	-0.20
1.0≤α<3.0	-21.85	0.44	0.00	13.16	-0.23	0.00	50.16	-1.09	0.00	-0.20
3.0≤α<4.0	4.43	0.04	0.00	-5.63	0.04	0.00	24.09	-0.48	0.00	-0.20
4.0≤α<6.0	89.76	-0.79	0.00	-69.45	0.64	0.00	-29.28	0.19	0.00	-0.20
6.0≤α<8.0	-96.69	1.05	0.00	67.05	-0.72	0.00	34.10	-0.37	0.00	-0.50
8.0≤α<10	-53.32	1.13	-0.01	44.64	-0.98	0.01	11.00	-0.17	0.00	-0.17
10≤α<15	0.00	0.05	0.00	2.89	-0.08	0.00	-0.49	0.02	0.00	-0.30
15≤α<40	-1.76	0.07	0.00	3.82	-0.07	0.00	-0.07	0.00	0.00	-0.30
40≤α<85	-0.80	0.01	0.00	150.88	20.84	-0.04	0.01	0.00	0.00	-4.80

Regression Coefficients for Spectral Class 210 - σ=20000										
	X_1	X_2	X_3	X_4	X_5	X6	X_7	X_8	X_9	Y
α<0.4	3.52	-0.02	0.00	0.36	0.01	0.00	-64.13	0.63	0.01	-0.20
0.4≤α<0.7	2.12	0.01	0.00	0.73	-0.01	0.00	40.18	-0.19	0.00	-0.30
0.7≤α<1.0	0.90	-0.02	0.00	2.35	0.00	0.00	-9.18	0.80	0.00	-0.10
1.0≤α<3.0	1.90	0.08	0.00	1.23	-0.05	0.00	-6.62	-0.05	0.00	-0.20
3.0≤α<4.0	-1.74	-0.04	0.00	4.49	0.04	0.00	-5.16	0.02	0.00	-0.10
4.0≤α<6.0	0.82	0.02	0.00	1.96	0.00	0.00	-5.08	-0.02	0.00	-0.20
6.0≤α<8.0	-12.25	0.19	0.00	10.75	-0.12	0.00	0.59	-0.09	0.00	-0.40
8.0≤α<10	-62.50	0.57	0.00	55.28	-0.46	0.00	6.34	-0.13	0.00	-0.24
10≤α<15	-66.79	-2.40	0.01	62.78	2.26	-0.01	3.10	0.12	0.00	-0.17
15≤α<40	2.69	-0.20	0.00	-4.39	0.18	0.00	0.01	0.01	0.00	-0.30
40≤α<85	-2.41	0.41	-0.01	4.60	-0.77	0.02	0.01	0.00	0.00	-0.50

Regression Coefficients for Spectral Class 211 - σ=20000										
	X_1	X_2	X_3	X_4	X_5	X6	X_7	X_8	X_9	Y
α<0.4	3.26	-0.01	0.00	0.25	0.00	0.00	-155.31	2.77	-0.01	-0.30
0.4≤α<0.7	5.83	-0.07	0.00	-0.73	0.02	0.00	-151.67	3.91	-0.02	-0.30
0.7≤α<1.0	3.11	0.01	0.00	0.18	0.00	0.00	-10.29	0.35	0.00	-0.30
1.0≤α<3.0	2.12	0.07	0.00	0.82	-0.04	0.00	-4.91	-0.05	0.00	-0.20
3.0≤α<4.0	-0.75	-0.03	0.00	3.38	0.04	0.00	-3.89	0.01	0.00	-0.10
4.0≤α<6.0	4.90	-0.05	0.00	-1.59	0.06	0.00	-5.05	-0.01	0.00	-0.10
6.0≤α<8.0	-8.17	0.14	0.00	7.28	-0.08	0.00	0.44	-0.07	0.00	-0.50
8.0≤α<10	-55.80	0.24	0.00	49.64	-0.18	0.00	5.53	-0.06	0.00	-0.25
10≤α<15	-39.32	-1.40	0.01	37.01	1.34	-0.01	1.66	0.06	0.00	-0.17
15≤α<40	18.57	0.15	0.00	-22.67	-0.20	0.00	-0.48	0.00	0.00	-0.50
40≤α<85	38.22	1.57	-0.03	-55.20	-2.17	0.04	-0.15	-0.01	0.00	-0.30

Regression Coefficients for Spectral Class 212 - σ=20000										
	X_1	X_2	X_3	X_4	X_5	X6	X_7	X_8	X_9	Y
α<0.4	-1.44	0.06	0.00	0.27	0.00	0.00	-1287.50	31.02	-0.13	-0.50
0.4≤α<0.7	133.01	-2.84	0.01	-95.26	2.06	-0.01	-2146.87	49.25	-0.20	-0.10
0.7≤α<1.0	7.70	1.17	-0.01	-8.18	-0.77	0.00	180.65	-11.73	0.06	-0.10
1.0≤α<3.0	42.91	-0.83	0.00	-26.78	0.56	0.00	-122.05	2.32	-0.01	-0.20
3.0≤α<4.0	15.94	0.29	0.00	-19.05	-0.09	0.00	37.68	-1.07	0.00	-0.10
4.0≤α<6.0	-146.07	2.65	-0.01	114.96	-2.05	0.01	55.11	-1.01	0.00	-0.20
6.0≤α<8.0	-102.08	1.74	-0.01	75.39	-1.26	0.00	29.99	-0.52	0.00	-0.40
8.0≤α<10	-7.48	-0.68	0.00	6.14	0.59	0.00	0.88	0.13	0.00	-0.26
10≤α<15	93.22	1.66	-0.01	-88.76	-1.53	0.01	-4.70	-0.10	0.00	-0.17
15≤α<40	-1.26	-0.18	0.00	1.78	0.24	0.00	-0.01	0.01	0.00	-0.80
40≤α<85	-2.69	0.05	0.00	635.66	11.86	-0.30	0.04	0.00	0.00	-4.80

Regression Coefficients for Spectral Class 213 - σ=20000										
	X_1	X_2	X_3	X_4	X_5	X6	X_7	X_8	X_9	Y
$\alpha<0.4$	1.89	0.02	0.00	0.01	0.00	0.00	72.15	-2.16	0.01	-0.50
$0.4\leq\alpha<0.7$	-5.60	0.18	0.00	3.81	-0.08	0.00	241.37	-5.00	0.02	-0.20
$0.7\leq\alpha<1.0$	1.36	0.04	0.00	0.38	-0.01	0.00	-20.04	0.41	0.00	-0.30
$1.0\leq\alpha<3.0$	-1.15	0.10	0.00	1.57	-0.04	0.00	-8.33	0.02	0.00	-0.30
$3.0\leq\alpha<4.0$	-1.62	0.02	0.00	1.61	0.03	0.00	1.87	-0.08	0.00	-0.10
$4.0\leq\alpha<6.0$	6.04	-0.11	0.00	-3.84	0.10	0.00	-0.30	0.01	0.00	-0.40
$6.0\leq\alpha<8.0$	4.81	0.03	0.00	-2.67	0.00	0.00	-1.33	-0.02	0.00	-0.30
$8.0\leq\alpha<10$	-15.72	-0.93	0.01	15.75	0.84	-0.01	0.46	0.11	0.00	-0.20
$10\leq\alpha<15$	-34.53	0.63	0.00	33.02	-0.56	0.00	1.96	-0.05	0.00	-0.20
$15\leq\alpha<40$	-32.45	-0.79	0.00	34.63	0.82	0.00	0.24	0.01	0.00	-0.17
$40\leq\alpha<85$	-4.71	1.88	-0.01	3.97	-2.40	0.01	0.04	0.00	0.00	-0.20

Regression Coefficients for Spectral Class 214 - σ=20000										
	X_1	X_2	X_3	X_4	X_5	X6	X_7	X_8	X_9	Y
$\alpha<0.4$	13.07	-0.16	0.00	-5.55	0.08	0.00	-452.73	5.20	-0.01	-0.20
$0.4\leq\alpha<0.7$	-16.29	0.42	0.00	6.35	-0.15	0.00	826.54	-17.38	0.07	-0.30
$0.7\leq\alpha<1.0$	9.51	-0.35	0.00	-5.38	0.26	0.00	-114.78	4.44	-0.02	-0.10
$1.0\leq\alpha<3.0$	-1.46	0.11	0.00	1.73	-0.05	0.00	-40.74	0.29	0.00	-0.30
$3.0\leq\alpha<4.0$	1.23	0.05	0.00	-3.25	0.02	0.00	2.91	-0.16	0.00	-0.20
$4.0\leq\alpha<6.0$	39.82	-0.56	0.00	-35.75	0.52	0.00	6.19	-0.03	0.00	-0.20
$6.0\leq\alpha<8.0$	86.88	-0.52	0.00	-65.98	0.41	0.00	-20.94	0.12	0.00	-0.30
$8.0\leq\alpha<10$	33.16	-0.33	0.00	-23.51	0.27	0.00	-9.23	0.06	0.00	-0.16
$10\leq\alpha<15$	-78.18	-1.79	0.01	73.03	1.73	-0.01	5.10	0.08	0.00	-0.17
$15\leq\alpha<40$	-0.92	-0.02	0.00	14.51	0.09	0.00	0.00	0.00	0.00	-4.50
$40\leq\alpha<85$	-0.89	0.10	0.00	65.02	-53.00	0.79	0.02	0.00	0.00	-4.80

Regression Coefficients for Spectral Class 215 - σ=20000										
	X_1	X_2	X_3	X_4	X_5	X6	X_7	X_8	X_9	Y
$\alpha<0.4$	3.70	0.01	0.00	0.02	0.00	0.00	-67.26	0.67	0.00	-0.60
$0.4\leq\alpha<0.7$	3.57	0.00	0.00	0.04	0.00	0.00	-16.42	0.56	0.00	-0.40
$0.7\leq\alpha<1.0$	2.68	0.04	0.00	0.57	-0.02	0.00	-3.71	-0.01	0.00	-0.20
$1.0\leq\alpha<3.0$	2.53	0.04	0.00	0.53	-0.02	0.00	-4.67	0.02	0.00	-0.30
$3.0\leq\alpha<4.0$	-3.85	-0.01	0.00	4.46	0.01	0.00	3.45	0.05	0.00	-0.30
$4.0\leq\alpha<6.0$	-1.95	0.09	0.00	2.95	-0.04	0.00	1.68	-0.05	0.00	-0.40
$6.0\leq\alpha<8.0$	-5.38	0.09	0.00	6.59	-0.05	0.00	0.95	-0.03	0.00	-0.20
$8.0\leq\alpha<10$	-2.13	-0.29	0.00	4.12	0.27	0.00	-0.10	0.03	0.00	-0.20
$10\leq\alpha<15$	-2.04	0.10	0.00	4.47	-0.07	0.00	-0.53	-0.01	0.00	-0.20
$15\leq\alpha<40$	-17.96	-0.11	0.00	20.57	0.12	0.00	0.30	0.00	0.00	-0.30
$40\leq\alpha<85$	-16.90	1.09	0.00	21.92	-1.36	0.01	0.04	0.00	0.00	-0.20

Regression Coefficients for Spectral Class 216 - σ=20000										
	X_1	X_2	X_3	X_4	X_5	X6	X_7	X_8	X_9	Y
$\alpha<0.4$	1.48	0.01	0.00	0.32	0.00	0.00	-116.46	3.71	-0.01	-0.30
$0.4\leq\alpha<0.7$	1.20	0.03	0.00	0.35	-0.01	0.00	5.92	0.82	0.00	-0.30
$0.7\leq\alpha<1.0$	4.88	-0.05	0.00	-2.02	0.05	0.00	-50.61	1.63	-0.01	-0.10
$1.0\leq\alpha<3.0$	-2.87	0.17	0.00	2.98	-0.09	0.00	-2.34	-0.26	0.00	-0.20
$3.0\leq\alpha<4.0$	2.42	0.05	0.00	-1.34	0.00	0.00	-2.19	-0.16	0.00	-0.10
$4.0\leq\alpha<6.0$	-4.65	-0.08	0.00	3.54	0.08	0.00	3.68	-0.04	0.00	-0.30
$6.0\leq\alpha<8.0$	-15.36	0.14	0.00	10.40	-0.08	0.00	7.57	-0.10	0.00	-0.50
$8.0\leq\alpha<10$	-68.50	0.37	0.00	60.12	-0.33	0.00	9.39	-0.05	0.00	-0.25
$10\leq\alpha<15$	-8.76	0.11	0.00	9.29	-0.12	0.00	0.45	0.00	0.00	-0.20
$15\leq\alpha<40$	-10.70	0.14	0.00	12.57	-0.15	0.00	0.06	0.00	0.00	-0.20
$40\leq\alpha<85$	-1.63	0.03	0.00	714.77	10.02	0.04	0.03	0.00	0.00	-4.80

Regression Coefficients for Spectral Class 217 - σ=20000

	X_1	X_2	X_3	X_4	X_5	X6	X_7	X_8	X_9	Y
$\alpha<0.4$	3.52	-0.04	0.00	0.39	0.01	0.00	-47.62	1.34	0.00	-0.20
$0.4\le\alpha<0.7$	-1.76	0.09	0.00	2.14	-0.04	0.00	203.61	-3.48	0.01	-0.30
$0.7\le\alpha<1.0$	1.99	-0.13	0.00	1.65	0.08	0.00	-30.56	2.02	-0.01	-0.10
$1.0\le\alpha<3.0$	2.78	0.06	0.00	0.57	-0.03	0.00	-14.15	-0.01	0.00	-0.30
$3.0\le\alpha<4.0$	1.49	-0.01	0.00	1.12	0.01	0.00	-10.84	0.06	0.00	-0.40
$4.0\le\alpha<6.0$	-14.90	0.08	0.00	13.79	-0.05	0.00	-2.01	-0.05	0.00	-0.20
$6.0\le\alpha<8.0$	-36.45	0.11	0.00	26.10	-0.05	0.00	11.32	-0.10	0.00	-0.40
$8.0\le\alpha<10$	-62.09	0.01	0.00	50.41	0.00	0.00	11.81	-0.03	0.00	-0.30
$10\le\alpha<15$	-5.73	1.86	-0.01	4.67	-1.81	0.01	1.29	-0.08	0.00	-0.18
$15\le\alpha<40$	3.00	0.03	0.00	-2.48	-0.08	0.00	-0.19	0.00	0.00	-2.00
$40\le\alpha<85$	9.80	0.89	-0.02	-14.71	-1.25	0.03	-0.03	0.00	0.00	-0.30

Regression Coefficients for Spectral Class 218 - σ=20000

	X_1	X_2	X_3	X_4	X_5	X6	X_7	X_8	X_9	Y
$\alpha<0.4$	2.88	-0.01	0.00	0.22	0.00	0.00	-19.92	-0.34	0.00	-0.20
$0.4\le\alpha<0.7$	1.52	0.02	0.00	0.63	-0.01	0.00	51.19	-0.84	0.00	-0.30
$0.7\le\alpha<1.0$	1.55	-0.04	0.00	1.28	0.03	0.00	-9.08	0.65	0.00	-0.10
$1.0\le\alpha<3.0$	1.81	0.04	0.00	0.82	-0.03	0.00	-4.57	0.01	0.00	-0.20
$3.0\le\alpha<4.0$	1.14	0.01	0.00	1.48	0.00	0.00	-4.06	0.03	0.00	-0.10
$4.0\le\alpha<6.0$	-0.36	0.03	0.00	2.35	-0.02	0.00	-2.24	-0.01	0.00	-0.20
$6.0\le\alpha<8.0$	-3.96	0.06	0.00	4.89	-0.04	0.00	-0.83	-0.02	0.00	-0.30
$8.0\le\alpha<10$	-15.69	0.07	0.00	15.18	-0.05	0.00	0.58	-0.01	0.00	-0.25
$10\le\alpha<15$	-9.45	-0.76	0.00	9.79	0.74	0.00	-0.34	0.03	0.00	-0.18
$15\le\alpha<40$	-18.72	-0.30	0.00	18.60	0.31	0.00	0.27	0.00	0.00	-0.20
$40\le\alpha<85$	10.22	0.86	-0.01	-17.56	-1.37	0.01	-0.03	0.00	0.00	-0.40

Regression Coefficients for Spectral Class 219 - σ=20000

	X_1	X_2	X_3	X_4	X_5	X6	X_7	X_8	X_9	Y
$\alpha<0.4$	3.05	-0.02	0.00	0.27	0.01	0.00	-16.08	-0.17	0.00	-0.20
$0.4\le\alpha<0.7$	-0.43	0.06	0.00	1.42	-0.02	0.00	139.17	-2.54	0.01	-0.30
$0.7\le\alpha<1.0$	2.38	-0.13	0.00	0.89	0.09	0.00	-25.02	1.60	-0.01	-0.10
$1.0\le\alpha<3.0$	1.56	0.07	0.00	1.12	-0.04	0.00	-8.87	0.01	0.00	-0.20
$3.0\le\alpha<4.0$	0.47	0.07	0.00	1.79	-0.05	0.00	-6.21	-0.01	0.00	-0.20
$4.0\le\alpha<6.0$	-5.78	0.06	0.00	6.37	-0.03	0.00	-1.57	-0.03	0.00	-0.20
$6.0\le\alpha<8.0$	-8.59	0.05	0.00	7.32	-0.02	0.00	0.88	-0.03	0.00	-0.40
$8.0\le\alpha<10$	-55.02	0.44	0.00	48.21	-0.36	0.00	6.46	-0.08	0.00	-0.24
$10\le\alpha<15$	-64.66	2.32	-0.01	61.15	-2.21	0.01	3.35	-0.12	0.00	-0.17
$15\le\alpha<40$	0.61	-0.01	0.00	-4.11	-0.04	0.00	-0.05	0.00	0.00	-4.80
$40\le\alpha<85$	3.44	0.86	-0.01	-5.49	-1.20	0.02	-0.01	0.00	0.00	-0.30

Regression Coefficients for Spectral Class 220 - σ=20000

	X_1	X_2	X_3	X_4	X_5	X6	X_7	X_8	X_9	Y
$\alpha<0.4$	3.24	-0.02	0.00	0.23	0.01	0.00	-32.18	0.14	0.00	-0.20
$0.4\le\alpha<0.7$	0.47	0.04	0.00	1.14	-0.02	0.00	102.17	-1.80	0.01	-0.30
$0.7\le\alpha<1.0$	1.81	-0.10	0.00	1.36	0.07	0.00	-15.64	1.26	-0.01	-0.10
$1.0\le\alpha<3.0$	2.59	0.04	0.00	0.43	-0.02	0.00	-8.01	0.02	0.00	-0.30
$3.0\le\alpha<4.0$	0.11	-0.02	0.00	2.64	0.02	0.00	-6.77	0.05	0.00	-0.10
$4.0\le\alpha<6.0$	0.02	0.04	0.00	1.39	-0.01	0.00	-3.16	0.00	0.00	-0.60
$6.0\le\alpha<8.0$	-20.52	0.20	0.00	17.24	-0.14	0.00	3.30	-0.06	0.00	-0.30
$8.0\le\alpha<10$	-43.94	0.28	0.00	38.45	-0.22	0.00	5.30	-0.05	0.00	-0.24
$10\le\alpha<15$	-8.93	-0.34	0.00	7.96	0.34	0.00	0.76	0.01	0.00	-0.17
$15\le\alpha<40$	-4.83	-0.13	0.00	5.61	0.12	0.00	-0.01	0.00	0.00	-0.20
$40\le\alpha<85$	6.03	0.70	-0.01	-11.20	-1.14	0.01	-0.01	0.00	0.00	-0.40

Regression Coefficients for Spectral Class 221 - σ=20000										
	X_1	X_2	X_3	X_4	X_5	X6	X_7	X_8	X_9	Y
α<0.4	3.48	-0.02	0.00	0.20	0.01	0.00	-19.90	-0.48	0.01	-0.20
0.4≤α<0.7	1.45	0.02	0.00	0.86	-0.01	0.00	75.04	-1.29	0.01	-0.30
0.7≤α<1.0	1.43	-0.04	0.00	1.78	0.02	0.00	-7.75	0.67	0.00	-0.10
1.0≤α<3.0	2.80	0.03	0.00	0.42	-0.02	0.00	-5.05	0.01	0.00	-0.30
3.0≤α<4.0	3.60	0.02	0.00	-0.12	-0.01	0.00	-5.55	0.02	0.00	-0.10
4.0≤α<6.0	2.25	0.02	0.00	0.58	-0.01	0.00	-3.75	-0.01	0.00	-0.50
6.0≤α<8.0	-2.40	0.06	0.00	3.86	-0.03	0.00	-1.88	-0.02	0.00	-0.40
8.0≤α<10	-22.12	0.17	0.00	21.25	-0.14	0.00	0.49	-0.03	0.00	-0.24
10≤α<15	-26.50	-1.99	0.01	25.49	1.91	-0.01	0.47	0.09	0.00	-0.18
15≤α<40	-1.31	-0.02	0.00	-3.94	0.01	0.00	0.16	0.00	0.00	-4.80
40≤α<85	-7.79	1.00	-0.01	17.53	-1.79	0.02	0.02	-0.01	0.00	-0.50

Regression Coefficients for Spectral Class 222 - σ=20000										
	X_1	X_2	X_3	X_4	X_5	X6	X_7	X_8	X_9	Y
α<0.4	2.12	-0.01	0.00	0.21	0.00	0.00	-124.44	5.02	-0.01	-0.30
0.4≤α<0.7	-1.14	0.09	0.00	0.93	-0.02	0.00	155.02	-2.33	0.01	-0.40
0.7≤α<1.0	1.31	0.08	0.00	0.37	-0.02	0.00	-15.46	-0.08	0.00	-0.40
1.0≤α<3.0	-3.26	0.20	0.00	3.42	-0.11	0.00	-7.84	-0.30	0.00	-0.20
3.0≤α<4.0	1.58	0.16	0.00	-0.73	-0.08	0.00	-2.81	-0.31	0.00	-0.20
4.0≤α<6.0	-0.18	-0.29	0.00	-0.13	0.21	0.00	3.83	0.05	0.00	-0.40
6.0≤α<8.0	-14.35	-0.06	0.00	10.50	0.03	0.00	6.98	0.00	0.00	-0.40
8.0≤α<10	-12.88	-1.42	0.01	12.56	1.22	-0.01	1.98	0.19	0.00	-0.20
10≤α<15	6.95	-0.24	0.00	-4.84	0.21	0.00	-0.54	0.03	0.00	-0.10
15≤α<40	-11.93	0.02	0.00	14.28	-0.01	0.00	0.06	0.00	0.00	-0.20
40≤α<85	-0.82	0.00	0.00	423.83	26.74	-0.03	0.01	0.00	0.00	-4.80

Regression Coefficients for Spectral Class 223 - σ=20000										
	X_1	X_2	X_3	X_4	X_5	X6	X_7	X_8	X_9	Y
α<0.4	3.19	-0.01	0.00	0.03	0.00	0.00	-99.53	2.05	0.00	-0.60
0.4≤α<0.7	-1.63	0.09	0.00	1.74	-0.03	0.00	161.91	-2.53	0.01	-0.30
0.7≤α<1.0	3.98	-0.18	0.00	-0.54	0.14	0.00	-49.51	2.62	-0.01	-0.10
1.0≤α<3.0	-0.44	0.14	0.00	2.13	-0.08	0.00	-12.55	-0.10	0.00	-0.20
3.0≤α<4.0	0.30	0.01	0.00	1.37	0.03	0.00	-7.88	-0.06	0.00	-0.10
4.0≤α<6.0	-11.16	0.00	0.00	8.23	0.03	0.00	5.44	-0.09	0.00	-0.30
6.0≤α<8.0	-25.32	-0.07	0.00	19.52	0.07	0.00	8.19	-0.03	0.00	-0.30
8.0≤α<10	-59.18	0.60	0.00	51.31	-0.53	0.00	9.12	-0.09	0.00	-0.24
10≤α<15	6.33	0.33	0.00	-4.83	-0.34	0.00	-0.29	0.00	0.00	-0.17
15≤α<40	-6.94	0.22	0.00	8.97	-0.24	0.00	0.01	0.00	0.00	-0.20
40≤α<85	-0.75	0.02	0.00	409.03	5.21	0.22	0.01	0.00	0.00	-4.80

Regression Coefficients for Spectral Class 224 - σ=20000										
	X_1	X_2	X_3	X_4	X_5	X6	X_7	X_8	X_9	Y
α<0.4	2.23	0.00	0.00	0.52	0.00	0.00	-55.30	1.38	0.00	-0.20
0.4≤α<0.7	-0.53	0.06	0.00	1.86	-0.03	0.00	73.21	-0.95	0.00	-0.20
0.7≤α<1.0	1.42	0.06	0.00	0.96	-0.03	0.00	-11.72	0.22	0.00	-0.20
1.0≤α<3.0	-0.22	0.12	0.00	1.97	-0.06	0.00	-6.91	-0.08	0.00	-0.20
3.0≤α<4.0	0.40	0.00	0.00	1.55	0.03	0.00	-5.52	-0.01	0.00	-0.10
4.0≤α<6.0	-5.39	-0.03	0.00	5.52	0.05	0.00	-0.14	-0.03	0.00	-0.20
6.0≤α<8.0	-21.66	0.22	0.00	16.20	-0.14	0.00	6.80	-0.10	0.00	-0.40
8.0≤α<10	-43.23	0.15	0.00	37.25	-0.11	0.00	6.60	-0.05	0.00	-0.25
10≤α<15	-12.43	-0.02	0.00	11.90	0.02	0.00	1.14	0.00	0.00	-0.30
15≤α<40	-7.60	0.24	0.00	9.01	-0.26	0.00	0.05	0.00	0.00	-0.20
40≤α<85	-1.74	0.02	0.00	917.74	0.84	0.10	0.03	0.00	0.00	-4.80

Regression Coefficients for Spectral Class 225 - σ=20000										
	X_1	X_2	X_3	X_4	X_5	X6	X_7	X_8	X_9	Y
α<0.4	-3.32	0.10	0.00	0.42	-0.01	0.00	-78.80	7.08	-0.03	-0.50
0.4≤α<0.7	9.75	-0.14	0.00	-3.96	0.08	0.00	-400.99	9.79	-0.04	-0.30
0.7≤α<1.0	7.39	0.41	0.00	-6.42	-0.24	0.00	-8.48	-2.48	0.02	-0.10
1.0≤α<3.0	2.84	0.03	0.00	-2.38	0.04	0.00	13.83	-0.50	0.00	-0.20
3.0≤α<4.0	-1.85	0.19	0.00	2.52	-0.11	0.00	-3.36	-0.16	0.00	-0.20
4.0≤α<6.0	-6.71	-0.02	0.00	4.72	0.05	0.00	7.08	-0.09	0.00	-0.30
6.0≤α<8.0	-59.98	0.54	0.00	52.25	-0.45	0.00	9.45	-0.09	0.00	-0.20
8.0≤α<10	140.71	-1.16	0.00	-135.59	1.12	0.00	-4.40	0.04	0.00	-0.06
10≤α<15	-38.46	1.78	-0.01	37.36	-1.69	0.01	1.96	-0.09	0.00	-0.20
15≤α<40	-5.35	0.08	0.00	6.13	-0.06	0.00	0.00	0.00	0.00	-0.20
40≤α<85	-1.58	0.05	0.00	246.82	7.95	0.12	0.02	0.00	0.00	-4.80

Regression Coefficients for Spectral Class 226 - σ=20000										
	X_1	X_2	X_3	X_4	X_5	X6	X_7	X_8	X_9	Y
α<0.4	3.17	-0.01	0.00	0.32	0.00	0.00	-20.42	-0.10	0.00	-0.20
0.4≤α<0.7	2.11	0.02	0.00	0.30	0.00	0.00	79.56	-1.41	0.01	-0.50
0.7≤α<1.0	1.94	-0.01	0.00	1.37	0.01	0.00	-16.25	0.75	0.00	-0.10
1.0≤α<3.0	1.62	0.07	0.00	1.23	-0.04	0.00	-6.71	0.00	0.00	-0.20
3.0≤α<4.0	-0.19	-0.01	0.00	2.82	0.02	0.00	-4.65	0.02	0.00	-0.10
4.0≤α<6.0	-0.33	0.03	0.00	2.15	-0.01	0.00	-2.08	-0.02	0.00	-0.30
6.0≤α<8.0	-13.21	0.15	0.00	12.02	-0.10	0.00	1.72	-0.05	0.00	-0.30
8.0≤α<10	-33.90	0.13	0.00	30.35	-0.09	0.00	3.96	-0.04	0.00	-0.25
10≤α<15	-41.50	1.32	-0.01	40.32	-1.24	0.01	1.71	-0.08	0.00	-0.17
15≤α<40	-0.67	-0.01	0.00	2.65	-0.03	0.00	0.12	0.00	0.00	-4.80
40≤α<85	-35.99	2.02	-0.01	47.73	-2.51	0.02	0.06	-0.01	0.00	-0.20

Regression Coefficients for Spectral Class 227 - σ=20000										
	X_1	X_2	X_3	X_4	X_5	X6	X_7	X_8	X_9	Y
α<0.4	3.88	-0.04	0.00	0.31	0.01	0.00	-43.76	0.38	0.01	-0.20
0.4≤α<0.7	0.50	0.04	0.00	1.41	-0.02	0.00	121.63	-1.96	0.01	-0.30
0.7≤α<1.0	2.41	0.01	0.00	1.10	-0.01	0.00	-8.95	0.53	0.00	-0.20
1.0≤α<3.0	3.32	0.04	0.00	0.42	-0.02	0.00	-8.56	-0.02	0.00	-0.30
3.0≤α<4.0	-4.87	-0.07	0.00	7.61	0.06	0.00	-6.49	0.06	0.00	-0.10
4.0≤α<6.0	-0.16	0.03	0.00	3.20	-0.02	0.00	-7.77	0.01	0.00	-0.20
6.0≤α<8.0	-19.55	0.17	0.00	15.99	-0.12	0.00	1.42	-0.06	0.00	-0.40
8.0≤α<10	-98.12	0.25	0.00	84.95	-0.19	0.00	11.44	-0.07	0.00	-0.24
10≤α<15	-88.55	3.27	-0.02	81.26	-3.12	0.02	5.86	-0.17	0.00	-0.17
15≤α<40	20.15	0.13	0.00	-22.10	-0.17	0.00	-0.49	0.00	0.00	-0.40
40≤α<85	38.85	2.04	-0.04	-49.97	-2.57	0.05	-0.10	-0.01	0.00	-0.20

Regression Coefficients for Spectral Class 301 - σ=20000										
	X_1	X_2	X_3	X_4	X_5	X6	X_7	X_8	X_9	Y
α<0.4	3.13	-0.02	0.00	0.37	0.01	0.00	-42.24	0.78	0.00	-0.20
0.4≤α<0.7	0.54	0.05	0.00	0.83	-0.01	0.00	136.13	-2.34	0.01	-0.40
0.7≤α<1.0	3.06	-0.15	0.00	0.55	0.10	0.00	-33.69	1.95	-0.01	-0.10
1.0≤α<3.0	1.33	0.09	0.00	1.38	-0.06	0.00	-10.16	-0.03	0.00	-0.20
3.0≤α<4.0	0.96	0.00	0.00	1.75	0.02	0.00	-8.55	0.02	0.00	-0.10
4.0≤α<6.0	-7.42	0.03	0.00	7.66	-0.01	0.00	-1.70	-0.04	0.00	-0.20
6.0≤α<8.0	-20.45	0.15	0.00	15.44	-0.09	0.00	5.46	-0.09	0.00	-0.40
8.0≤α<10	-49.09	-0.02	0.00	41.90	0.04	0.00	7.18	-0.03	0.00	-0.26
10≤α<15	-58.99	1.22	-0.01	55.69	-1.19	0.01	3.40	-0.06	0.00	-0.17
15≤α<40	1.53	0.01	0.00	-4.27	-0.13	0.00	-0.08	0.00	0.00	-4.80
40≤α<85	-1.28	0.03	0.00	850.29	-7.54	0.29	0.02	0.00	0.00	-4.80

Regression Coefficients for Spectral Class 302 - σ=20000										
	X_1	X_2	X_3	X_4	X_5	X6	X_7	X_8	X_9	Y
α<0.4	4.44	-0.03	0.00	-1.29	0.03	0.00	-98.31	2.20	0.00	-0.20
0.4≤α<0.7	-7.88	0.24	0.00	3.42	-0.08	0.00	433.05	-8.54	0.03	-0.30
0.7≤α<1.0	6.87	-0.21	0.00	-3.50	0.17	0.00	-87.28	3.33	-0.02	-0.10
1.0≤α<3.0	-7.38	0.25	0.00	5.67	-0.14	0.00	-3.28	-0.34	0.00	-0.20
3.0≤α<4.0	2.19	-0.02	0.00	-2.22	0.07	0.00	2.01	-0.16	0.00	-0.20
4.0≤α<6.0	14.62	-0.41	0.00	-12.98	0.37	0.00	5.25	-0.03	0.00	-0.20
6.0≤α<8.0	93.91	0.14	0.00	-83.83	-0.13	0.00	-9.78	-0.02	0.00	-0.10
8.0≤α<10	-95.62	0.62	0.00	85.35	-0.55	0.00	11.28	-0.07	0.00	-0.25
10≤α<15	18.61	-0.15	0.00	-16.41	0.13	0.00	-1.36	0.02	0.00	-0.30
15≤α<40	-11.81	0.11	0.00	13.83	-0.11	0.00	0.07	0.00	0.00	-0.20
40≤α<85	-1.12	0.02	0.00	366.32	11.40	0.23	0.02	0.00	0.00	-4.80

Regression Coefficients for Spectral Class 303 - σ=20000										
	X_1	X_2	X_3	X_4	X_5	X6	X_7	X_8	X_9	Y
α<0.4	2.38	-0.04	0.00	0.53	0.01	0.00	-19.06	3.41	-0.01	-0.20
0.4≤α<0.7	-4.20	0.16	0.00	1.92	-0.04	0.00	369.13	-7.15	0.03	-0.40
0.7≤α<1.0	5.74	-0.32	0.00	-1.67	0.23	0.00	-76.46	4.02	-0.02	-0.10
1.0≤α<3.0	-1.44	0.18	0.00	2.83	-0.11	0.00	-17.41	-0.16	0.00	-0.20
3.0≤α<4.0	2.12	0.03	0.00	-0.48	0.01	0.00	-10.04	-0.14	0.00	-0.20
4.0≤α<6.0	-22.87	-0.48	0.00	17.51	0.41	0.00	10.94	0.02	0.00	-0.20
6.0≤α<8.0	-8.81	-0.49	0.00	6.18	0.37	0.00	5.78	0.11	0.00	-0.30
8.0≤α<10	7.68	-1.02	0.00	-6.39	0.86	0.00	0.71	0.15	0.00	-0.20
10≤α<15	25.30	1.11	-0.01	-21.84	-1.07	0.01	-1.49	-0.04	0.00	-0.17
15≤α<40	-21.57	-0.06	0.00	24.81	0.07	0.00	0.20	0.00	0.00	-0.20
40≤α<85	-1.26	-0.04	0.00	1043.50	45.58	-0.25	0.02	0.00	0.00	-4.80

Regression Coefficients for Spectral Class 304 - σ=20000										
	X_1	X_2	X_3	X_4	X_5	X6	X_7	X_8	X_9	Y
α<0.4	2.74	-0.01	0.00	0.47	0.01	0.00	-40.43	0.59	0.00	-0.17
0.4≤α<0.7	0.89	0.04	0.00	0.94	-0.01	0.00	77.05	-1.16	0.01	-0.30
0.7≤α<1.0	3.55	-0.13	0.00	-0.04	0.09	0.00	-30.65	1.61	-0.01	-0.10
1.0≤α<3.0	2.25	0.04	0.00	0.41	-0.01	0.00	-8.05	0.00	0.00	-0.40
3.0≤α<4.0	-0.10	0.15	0.00	2.16	-0.10	0.00	-5.07	-0.08	0.00	-0.20
4.0≤α<6.0	-6.05	0.04	0.00	6.58	-0.01	0.00	-1.13	-0.02	0.00	-0.20
6.0≤α<8.0	-13.85	0.15	0.00	10.90	-0.09	0.00	3.61	-0.07	0.00	-0.40
8.0≤α<10	-34.04	0.09	0.00	29.87	-0.06	0.00	4.41	-0.04	0.00	-0.25
10≤α<15	-13.76	-0.46	0.00	13.39	0.44	0.00	0.60	0.02	0.00	-0.17
15≤α<40	-7.51	0.14	0.00	8.17	-0.16	0.00	0.11	0.00	0.00	-0.20
40≤α<85	-25.59	0.93	-0.01	32.96	-1.15	0.01	0.06	0.00	0.00	-0.20

Regression Coefficients for Spectral Class 305 - σ=20000

	X_1	X_2	X_3	X_4	X_5	X6	X_7	X_8	X_9	Y
α<0.4	3.41	-0.03	0.00	0.41	0.01	0.00	-24.10	0.96	0.00	-0.20
0.4≤α<0.7	-2.07	0.10	0.00	2.22	-0.04	0.00	223.37	-4.02	0.02	-0.30
0.7≤α<1.0	2.24	-0.12	0.00	1.45	0.08	0.00	-32.50	2.03	-0.01	-0.10
1.0≤α<3.0	1.62	0.10	0.00	1.43	-0.06	0.00	-13.16	-0.03	0.00	-0.20
3.0≤α<4.0	-1.21	0.20	0.00	3.31	-0.13	0.00	-8.35	-0.12	0.00	-0.20
4.0≤α<6.0	-14.16	0.03	0.00	12.98	0.00	0.00	-0.14	-0.04	0.00	-0.20
6.0≤α<8.0	-29.01	0.10	0.00	21.01	-0.05	0.00	9.47	-0.08	0.00	-0.40
8.0≤α<10	-48.23	-0.14	0.00	40.29	0.13	0.00	8.66	-0.01	0.00	-0.26
10≤α<15	24.45	0.21	0.00	-22.91	-0.22	0.00	-0.77	-0.01	0.00	-0.20
15≤α<40	-7.56	0.29	0.00	9.89	-0.32	0.00	0.05	0.00	0.00	-0.20
40≤α<85	-13.47	0.46	-0.01	20.43	-0.62	0.01	0.04	0.00	0.00	-0.30

Regression Coefficients for Spectral Class 306 - σ=20000

	X_1	X_2	X_3	X_4	X_5	X6	X_7	X_8	X_9	Y
α<0.4	1.75	0.02	0.00	0.19	0.00	0.00	-10.73	0.46	0.00	-0.30
0.4≤α<0.7	-2.26	0.12	0.00	2.24	-0.05	0.00	125.22	-2.28	0.01	-0.20
0.7≤α<1.0	1.39	0.08	0.00	0.53	-0.03	0.00	-21.34	0.28	0.00	-0.20
1.0≤α<3.0	-3.61	0.17	0.00	3.55	-0.09	0.00	-1.81	-0.17	0.00	-0.20
3.0≤α<4.0	2.37	0.01	0.00	-1.18	0.03	0.00	-1.29	-0.08	0.00	-0.20
4.0≤α<6.0	-0.68	-0.14	0.00	1.05	0.14	0.00	1.06	0.01	0.00	-0.20
6.0≤α<8.0	-17.45	0.27	0.00	12.86	-0.17	0.00	6.98	-0.11	0.00	-0.40
8.0≤α<10	-66.01	0.28	0.00	63.96	-0.24	0.00	3.14	-0.02	0.00	-0.08
10≤α<15	-0.87	-0.02	0.00	2.45	0.03	0.00	-0.47	0.00	0.00	-0.10
15≤α<40	-8.08	-0.22	0.00	9.46	0.23	0.00	0.02	0.00	0.00	-0.20
40≤α<85	-1.70	0.02	0.00	468.22	-4.33	-0.02	0.03	0.00	0.00	-4.80

Regression Coefficients for Spectral Class 307 - σ=20000

	X_1	X_2	X_3	X_4	X_5	X6	X_7	X_8	X_9	Y
α<0.4	2.36	-0.01	0.00	0.54	0.01	0.00	-68.98	1.31	0.00	-0.17
0.4≤α<0.7	1.68	0.01	0.00	0.56	-0.01	0.00	22.45	0.06	0.00	-0.30
0.7≤α<1.0	1.83	0.03	0.00	0.74	-0.02	0.00	-10.28	0.28	0.00	-0.20
1.0≤α<3.0	1.78	0.05	0.00	0.60	-0.02	0.00	-8.26	0.00	0.00	-0.30
3.0≤α<4.0	2.86	0.01	0.00	-0.28	0.00	0.00	-7.16	0.01	0.00	-0.10
4.0≤α<6.0	-2.08	0.03	0.00	2.89	0.00	0.00	-1.94	-0.02	0.00	-0.30
6.0≤α<8.0	-15.29	0.16	0.00	11.88	-0.10	0.00	3.56	-0.07	0.00	-0.40
8.0≤α<10	-47.10	0.14	0.00	40.76	-0.10	0.00	6.20	-0.04	0.00	-0.25
10≤α<15	-39.07	1.62	-0.01	37.08	-1.54	0.01	1.99	-0.09	0.00	-0.17
15≤α<40	-13.91	0.10	0.00	14.88	-0.13	0.00	0.16	0.00	0.00	-0.20
40≤α<85	-0.83	0.66	-0.01	1.01	-1.03	0.01	0.01	0.00	0.00	-0.40

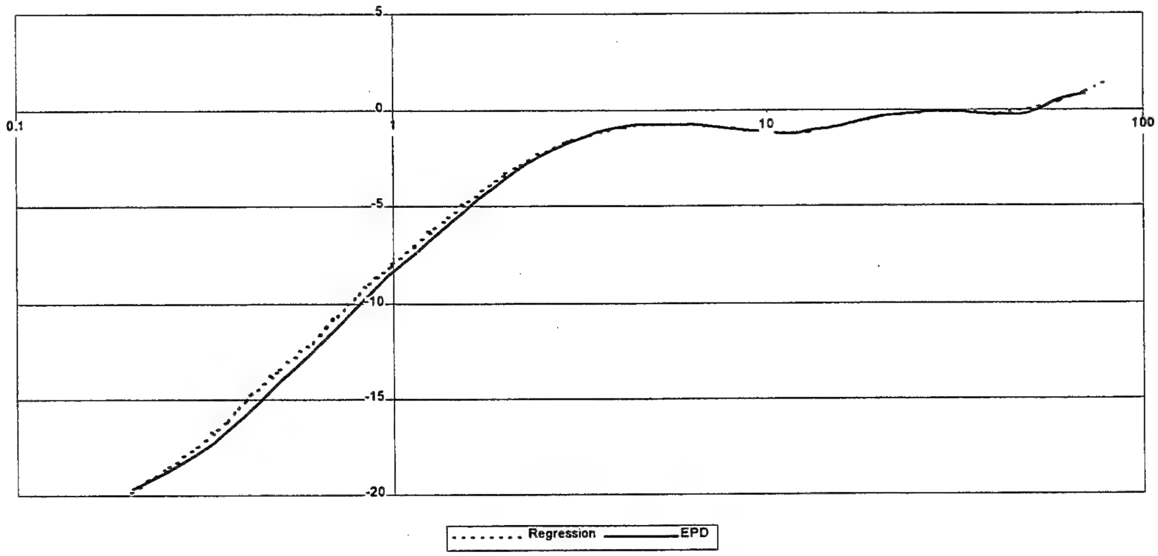


Figure 98. Comparison of Model Output and Regression

Departure Spectral Class 101; Distance=1000 m; Acoustically Soft Ground

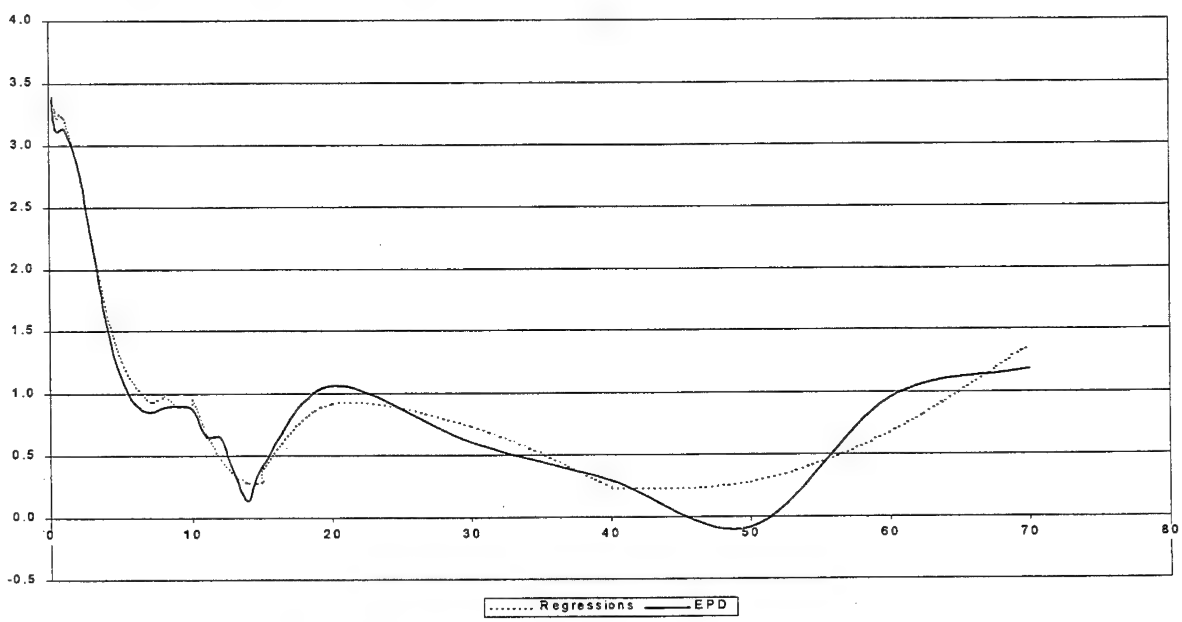


Figure 99. Comparison of Model Output and Regression

Departure Spectral Class 101; Distance=1000 m; Acoustically Hard Ground

practical limit that is supported in the literature.[54] Somewhat related to this constraint was the fact that for source-to-receiver distances greater than 6,000 m, the ground effect was computed at 6,000 m; and computed reflection angles of less than 0.1 degrees were evaluated in the regression equation for an angle equal to 0.1 degrees. Further, for the purpose of computing ground effect the nominal source height was set to 5 ft. when the aircraft was on the ground.

In addition, the small variation in the soft-ground effect for the larger reflection angles (as exhibited in Figure 98 for angles above about 30 degrees), although considered physically realistic and supported somewhat by the literature,[55,56] were considered impractical to represent in the final implementation for several reasons: (1) random variations in ground effect of +/- 0.5 dB abut a mean value are bounded by the accuracy associated with the spectral class groupings (see Tables 16 through 18), and are therefore considered insignificant; (2) acoustically soft-ground effects are generally considered to be negligible for reflection angles greater than about 20 degrees;[57] (3) the NPD data in the data base of the INM should be minimally affected by acoustically soft ground for elevation angles resembling those encountered at a centerline microphone during aircraft noise certification.[58] (In other words, there should be an inherent consistency between aircraft noise certification data and the INM NPD data); and (4) not evaluating the regression equation for large reflection angles will dramatically improve INM runtime.

Consequently, it was decided that the acoustically soft-ground regression equations would not be invoked for reflection angles of 30 degrees and above; and for angles below 30 degrees an increase in sound level due to acoustically soft ground would not be allowed. To ensure these restrictions did not introduce a discontinuity in the ground effect at 30 degrees, the actual regression equations were truncated at 20 degrees and a simple linear function which converged to 0 dB at 30 degrees was substituted for the regression equations at angles between 20 and 30 degrees. In general, the ground effect at an angle of 20 degrees (where the linear function was initiated) was less than 0.5 dB. The net result of this constraint is that acoustically soft ground can only reduce the computed sound level

in INM, as opposed to increasing the level.

In most cases, the acoustically soft-ground attenuation curve converged to zero at reflection angles between 5 and 20 degrees, depending upon aircraft type and source-to-receiver geometry, and therefore the 30 degree cutoff was rarely triggered. Table 21 presents a summary of the angles (prior to implementing the 30-degree cutoff) at which the acoustically soft ground effect is a positive value, assuming a fixed distance of 1000 m.

In addition, INM supports several types of operations beyond just departures and approaches. Specifically, the INM user is allowed to define overflights, circuits, runups and touch-and-go's. For implementation within INM, overflights, circuits, runups and touch-and-go's are evaluated using the appropriate departure regression.

The regression coefficients, along with the above mentioned constrains were implemented in INM for acoustically hard and soft ground situations. However, many practical modeling situations include propagation over mixed, acoustically hard and soft terrain. Consequently, a methodology had to be developed for properly accounting for such situations. The approach decided upon was very similar to that implemented within the Federal Highway Administration's Traffic Noise Model (FHWA TNM ®)[55,56] and is based on the work of Boulanger.[59] Specifically, the soft-ground and hard-ground attenuation were apportioned based on a distance-weighted coefficient. This coefficient was computed based on the ground distance associated with the acoustically hard and acoustically soft portion of the ground contained within the so-called Fresnel Ellipsoid.*

* The Fresnel Ellipsoid is a frequency-dependent function used fairly extensively in acoustics. The nature of the function is such that the ellipsoid effectively widens for lower frequencies and narrows for higher frequencies. The relationship is obviously made to be consistent with the relationship between the frequency of a sound and its wavelength. Because a comprehensive frequency-based implementation of the ellipsoid was not considered computationally viable, the ellipsoid was computed for an ***effective*** frequency of 44 Hz, the lower bandedge of the 50 Hz one-third-octave band. This frequency may be adjusted depending upon the results of some of the earlier-referenced propagation research currently underway.[23,24]

Table 21. Summary of Angular Cutoff; Distance=1000 m

Spectral Class	Angles where attenuation is zero
101	>30.0°
102	>3.5°
103	>30.0°
104	>14.6°
105	>30.0°
106	>9.4°
107	30.0°
108	3.6° to 6.2°, >30.0°
109	>30.0°
110	>19.7°
111	>30.0°
112	3.8° to 8.1°, >10.5°
113	>30.0°
114	>30.0°
115	>30.0°
116	1.7° to 6.8°, >11.6°
117	2.7° to 8.3°, >12.0°
118	2.5° to 7.6°, >17.8°
119	>30.0°
120	3.9° to 8.1°, >16.7°
121	>2.1°
122	>1.8°
123	>30.0°
201	>30.0°
202	3.3° to 11.2°, >17.5°
203	4.3° to 5.6°, >30.0°
204	>14.0°
205	>30.0°
206	2.7° to 9.1°, >17.2°
207	>16.4°
208	1.3° to 2.6°, 4.1° to 5.8°, 7.9° to 8.3°, >30.0°
209	1.5° to 4.9°, 6.7° to 9.6°, 13.0° to 15.4°, >30.0°
210	>18.0°
211	>19.5°

Spectral Class	Angles where attenuation is zero
212	2.8° to 3.6°, >30.0°
213	>30.0°
214	2.0° to 6.4°, >30.0°
215	>30.0°
216	>30.0°
217	>15.0°
218	>30.0°
219	>30.0°
220	>30.0°
221	>30.0°
222	>2.6°
223	>18.7°
224	>30.0°
225	>19.6°
226	>30.0°
227	>18.1°
301	>30.0°
302	2.1° to 6.2°, >30.0°
303	3.0° to 15.0°, >30.0°
304	>30.0°
304	>16.6°
306	>30.0°
307	>30.0°

For example, (see Figure 100), given a source-to-receiver ground distance of 1000 m, where the first 700 m of propagation is water (acoustically hard) and the remaining 300 m is grass (acoustically soft):

(1) the appropriate regression is evaluated assuming a pure acoustically soft situation;

(2) the appropriate regression is evaluated assuming a pure acoustically hard situation;

(3) the attenuation computed in Steps 1 and 2 for acoustically soft and acoustically hard ground, respectively, is combined in accordance with the following equation:

$$A_{Hard/Soft} = \left(\frac{d_1}{(d_1 + d_2)} \right) A_{Hard} + \left(\frac{d_2}{(d_1 + d_2)} \right) A_{Soft} \qquad \text{(dB)}$$

Where: $A_{Hard/Soft}$ is the attenuation in decibels for a mixed acoustically hard and soft geometry;

d_1 is the acoustically hard portion of the ground contained within the Fresnel Ellipsoid;

A_{Hard} is the attenuation computed assuming a pure acoustically hard ground situation;

d_2 is the acoustically soft portion of the ground contained within the Fresnel Ellipsoid; and

A_{Soft} is the attenuation computed assuming a pure acoustically soft ground situation.

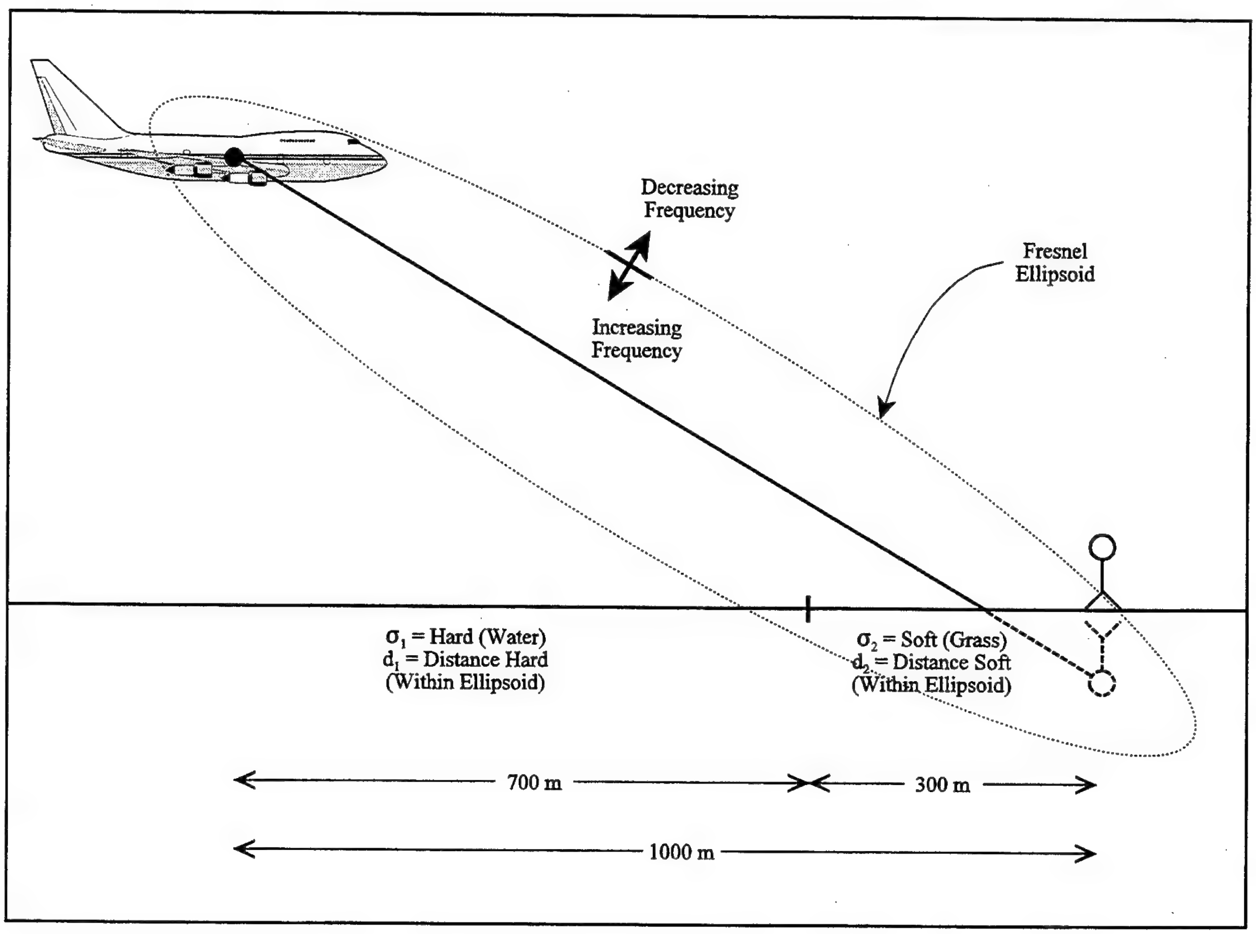


Figure 100. Example Geometry for Mixed Acoustically Hard and Soft Ground

D.1.6 Reference Hydrographical Data

A mechanism had to be developed within INM to facilitate automated input of acoustically hard terrain that was classified as such due to water cover, i.e., automated input of hydrographical data. The first step in this development was to establish a standardized file format for defining hydrographical objects such as lakes and rivers. The file format is overviewed in Figure 101. It includes a header at the beginning which contains the following information: (1) whether the geometric input is in ft. or nmi ("f" or "n"); (2) a reference latitude and longitude (not currently used); (3) the X and Y coordinates for the lower left hand (southwest) corner of the analysis window (in either ft or nmi); (4) the spacing between grid point (in either ft. or nmi); (5) the number of grid points on each side of the analysis window; (6) the grid rotation angle; and (7) the number of hydrographical areas.

Following the header are the hydrographical objects, defined as either polygons, e.g., lakes and ponds, or borders, e.g., rivers or coastlines. The file is structured such that it can contain an unlimited number of hydrographical objects. Each object contains its own header information (separate from the file header information) which includes: (1) the object sequence number in the file; (2) whether the object is acoustically hard or soft; (3) whether the object is a polygon (p) or a border (b), and (4) the number of X and Y points which define the object. The actual X and Y values for a given object then follow.

There are of course an abundance of sources for raw hydrographical data. One option, and probably the best in terms of accuracy, would be digitized information generated from maps or aerial photographs. This approach will obviously require a substantial amount of work on the part of the INM user. In some instances it may also leave the user in a quandary as to how to classify certain areas of land. For example, should an open area which is marshland in the spring, and dried-up field grass in the summer be classified as acoustically hard or acoustically soft? As a result, a more automated approach has been developed. A stand-alone program, entitled USGS reads either singular

or multiple contiguous United States Geological Survey (USGS) 1:100,000-scale hydrographical files and automatically converts them into the standard format defined above and in Figure 101. The only user requirement is that the raw hydrographical data be located in the same directory as the

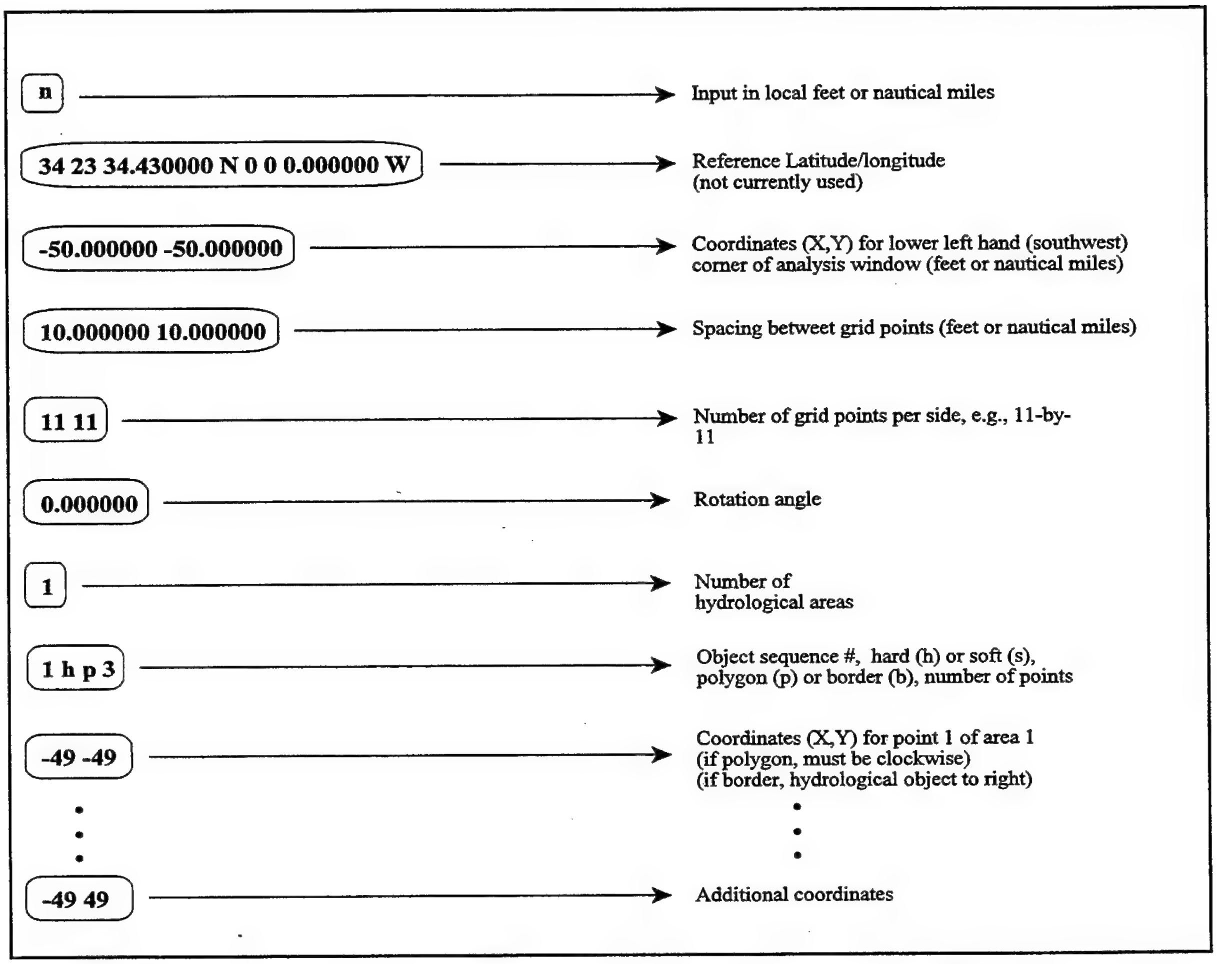


Figure 101. File Format for Defining Hydrographical Data

USGS program prior to execution. The USGS data are available online at *http://edcwww.cr.usgs.gov/glis/hyper/guide/100kdlgfig/states.html*. Viewer programs for the USGS data are also available online at *http://mcmcweb.er.usgs.gov/viewers*.

A second stand-alone supporting program, entitled HYDRO, converts the standard hydrographical file into a binary file of acoustically hard and acoustically soft regularly spaced grid points. This binary file is entitled GRID.BIN. It must reside in the INM case directory to ensure proper INM operation. The GRID.BIN file has a simple header which contains grid size, resolution, and registering information, along with a grid of "1s" and "0s", where "1s" represent acoustically hard ground and "0's" acoustically soft. The specific resolution of the grid is user selectable. This GRID.BIN file is used directly by the specially developed PROF subroutine in INM to determine the percentage of acoustically hard and acoustically soft ground in a given source-to-receiver cross section.

More specifically, the ground projection from the microphone to the closest-point-of-approach on a given flight segment is effectively overlayed on the GRID.BIN file. If the projection traverses acoustically hard or soft ground only, the appropriate ground effects regression equation is evaluated. If the projection traverses acoustically mixed grounds, it is necessary to determine the appropriate percentage of acoustically hard and soft ground distances.

It is important to point out that it is currently the responsibility of the INM user to ensure that the INM analysis "window" is consistent with the "window" defined by the GRID.BIN file. An INM analysis window which covers an area not represented by the GRID.BIN file will cause the model to fail.

D.2 Other Enhancements

To facilitate assessment in support of the Homestead SEIS, a special ASCII file entitled L&BGRID, is generated by INM when a grid point analysis is initiated. This file contains the following information for all user-defined grid points: (1) the aircraft which generated the largest L_{AE} at the point (Note: the one constraint imposed is that the aircraft must have been assigned at least one daily operation- this precludes the inclusion of a single very loud aircraft which only operates on rare occasion, e.g., monthly); (2) the L_{AE} for the aircraft; and (3) the flight track to which the aircraft was assigned. It is important to point out that in some instances the results presented in the L&BGRID file will appear to be inconsistent with those presented in a standard INM grid output file. The source of this apparent inconsistency is the imposition of the threshold of a single daily operation tied to the reported L_{AE} value in the L&BGRID file. The issue is best exemplified in Table 22, which presents L_{AE} and L_{ASmx} for four hypothetical aircraft. For ease of understanding, the aircraft are presented in order of highest to lowest L_{AE} value.

Table 22. Example L_{AE} and L_{ASmx} Comparison at a Single INM Grid Point

Aircraft	Daily Operations	L_{AE}	L_{ASmx}
1	0.01	92.2	*88.4*
2	0.06	89.4	84.1
3	1.2	*87.3*	83.6
4	1.8	86.6	83.1

The aircraft with the highest L_{ASmx} value is Aircraft 1. However, because of the single operation threshold limit imposed on the L&BGRID, the aircraft with the highest reported level in the L&B file is Aircraft 3. Consequently, care must be taken when comparing both L_{AE} and L_{ASmx} for a single grid point, so as to understand that in some instances these values may not be associated with the same aircraft. In such a case, one may want to manually impose the single operational limit on the L_{ASmx}.

D.3 Reasonableness Check of Enhanced INM

A brief analysis was conducted to quantify the relative accuracy of the enhanced version of the INM used in support of the Homestead SEIS, as compared to INM Version 5.2a (the latest publicly released version of the model). This comparison used noise measurement data collected as part of the ambient study and aircraft time-space-position data collected specifically for this comparative analysis.

The collection of the noise data is described in Section 4 of the main body of the document. The noise data used for this analysis were the data collected at Black Point (August 10, 1998) and Stiltsville (August 16 and 17, 1998). Black Point and Stiltsville were chosen as the measurement sites of interest because they were water-based measurement sites relatively close to Miami International Airport (MIA). Because water is acoustically hard, water-based measurement sites are expected to result in the largest differences between INM Version 5.2a (which uses only acoustically soft ground for lateral attenuation calculations) and the enhanced INM, which uses actual ground cover data (acoustically hard and soft) for its lateral attenuation calculations. Note that the Black Point nighttime measurements on August 12, 1998 were not used because the inability to see the aircraft meant that there was no way to verify the correlation of the ARTS data and the noise measurement logs.

Aircraft time-space-position data for operations at MIA were collected for the time periods corresponding to the noise measurements taken at Black Point and at Stiltsville. These data were collected to enable accurate modeling of aircraft position in the INM.

Aircraft time-space-position data were based on Automated Radar Terminal System (ARTS) data generated by the Air Traffic Control (ATC) radar system at MIA. These data were then processed by Landrum & Brown, Inc. into ASCII files. The ASCII files contained the following data used in the reasonableness check: aircraft type, time at the point of closest approach (CPA) to the

measurement site, angle above the horizon at CPA, and attitude at CPA.

The noise measurements consisted of 12 hours of aircraft observations (4 days at approximately 3 hours of measurements per day). These 12 hours of measurements were culled in several steps. First, all arrivals were eliminated. This was done because the INM only supports modeling of arrival operations from an altitude of 6000 feet down to the runway, but all arrivals in the ARTS data were above 6000 feet altitude at the CPA. Second, all propeller driven aircraft were eliminated. The ARTS data does not contain information on aircraft operating under Visual Flight Rules (VFR), which is common for propeller driven aircraft. Third, aircraft types with only one operation during the measurement period were eliminated. This was done to remove single data points which could not be checked for reasonableness. Fourth, all aircraft operations which were not positively identified by both airline and aircraft type were eliminated. This was done to eliminate any possibility of a mismatch between the ARTS data and the noise measurement data. All these culling steps left eight departures that had ARTS data correlated with aircraft audibility as noted on the measurement logs.

INM modeling of the eight operations was done using the INM's overflight function. Each aircraft was modeled at a constant altitude (the ARTS reported CPA altitude), a constant thrust setting (an INM net corrected thrust typical of the CPA altitude), and a slant distance from the INM location point equal to the slant distance reported in the ARTS data.

The INM modeled operations were run with both INM Version 5.2a and the enhanced version. Table 23 below presents the comparison of the modeled operations with the measured data. The differences between the models and the measured data are shown in the last two columns. Because these differences can be either positive and negative numbers, a Root-Mean Squared (RMS) difference was used to assess the variation between the two models and the measured data. RMS analyses provide an indication of how far the data are scattered from an expected difference of zero. In this analysis, a smaller RMS difference indicates a smaller difference between the modeled and measured data.

Table 23. L_{AE} Comparison of All Positively Identified Events

Aircraft	ARTS ID	Enhanced INM (dB)	INM 5.2a (dB)	Measured (dB)	Enhanced - Measured	INM 5.2a - Measured
B-727	213	77.1	75.7	77.3	-0.2	-1.6
B-727	260	80.0	80.0	77.1	+2.9	+2.9
B-727	264	82.5	82.3	83.4	-0.9	-1.1
B-727	451	88.6	88.5	87.4	+1.2	+1.1
B-727	477	70.5	65.5	73.6	-3.1	-8.1
B-727	494	80.1	76.9	75.8	+4.3	+1.1
A-300	461	69.1	68.3	68.9	+0.2	-0.6
MD-80	214	73.9	72.3	73.3	+0.6	-1.0
				RMS difference	2.2	3.2

Although the amount of data is limited, the RMS difference is relatively small. This small RMS difference means that the enhanced version of the INM can be considered reasonable.

The data scatter could be due to a number of sources. Some sources of data scatter may be different operational procedures than those which were modeled and inaccurate aircraft type assignments. Different operational procedures than modeled means that the thrust and flap settings for the actual operations may be different than the standard INM assumptions, which were used in the modeling. Aircraft type assignments means that an aircraft with a different series engine may have been modeled; e.g. the INM contains ten different types of B-727 aircraft with different versions of the JT8D engine, but all B-727 aircraft in this study were modeled as one type (727Q15, with the JT8D-15QN engine).

The difference between the soft ground lateral attenuation in INM Version 5.2a and the variable ground attenuation in the enhanced version of the INM is smallest for aircraft at high elevation angles and is largest for aircraft at low elevation angles. Given the distance of the measurement locations from MIA, and the climb rate of jet aircraft, aircraft at low elevation angles (less than ten degrees) at CPA would be greater than 30,000 feet from the measurement locations. Aircraft at these distance were not audible, and therefore were not included in the analysis. However, the datum with the lowest elevation angle (ARTS ID 477, 14 degrees) showed the largest improvement (5 dB) for the enhanced INM over Version 5.2a. The datum at the highest elevation angle (ARTS ID 264, 85 degrees) showed only a 0.2 dB improvement. The mean of all elevation angles in the current analysis is 52 degrees. The relatively small improvement associated with the enhanced version of the INM is expected due to the high elevation angles observed in the current analysis.

Three projects, both in work and planned, will provide additional data on the reasonableness of the enhanced INM. NASA recently completed and prepared a draft report on a study of lateral attenuation at Denver International Airport; a primary conclusion presented in this draft report is that the theoretical model presented herein is substantially more accurate than the lateral attenuation model presented in SAE AIR 1751.[60] NASA is also sponsoring a study at Logan Airport in Boston focusing on over-water sound propagation; measurements are scheduled to begin in May of 1999. The Society of Automotive Engineers A-21 committee on aircraft noise is proposing that Dallas-Ft. Worth Airport be used for a study on lateral attenuation over acoustically soft ground. The data collected in these three projects should provide a reliable statistical basis upon which to fully validate the INM enhancements.

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